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Cover Photo—Assistant Secretary of Defense Barry Shillito (at podium) briefs Vice President Agnew, Secretary Laird, Deputy Secretary Packard (seated at table) and other government officials on the Defense Department's management achievements in Fiscal Year 1969. See pages 50-64.

Treating People as People

By

ROGER T. KELLEY

*Assistant Secretary of
Defense for Manpower
and Reserve Affairs*

"Our Nation was founded on the principle that the individual has infinite dignity and worth."

So spoke Secretary of Defense Laird on August 18, 1969, in announcing the Human Goals of the Department of Defense. Mr. Laird went on: "The Department of Defense, which exists to keep the Nation secure and at peace, must always be guided by this principle. In all that we do, we must show respect for the serviceman and civilian employee as a person, recognizing his individual needs, aspirations and capabilities."

Treat each person as a person? That's a challenging goal. Can we translate it into reality? We not only can—we must. And for one simple reason. It's the right thing to do.

The dignity and individuality of every human being is the cornerstone of America. It sets us apart from other nations, and it forms the basis for our value system. And so we must put it to practice in the way we manage people. Let me attempt to express this vital human goal—treating each person as a person—in terms that will be useful to the manager.

The manager's job is to make things happen—through other people. So, if we are to draw upon the unique people resources in the range of our responsibility, we managers must take the time to know each person we supervise—his needs, aspirations and capabilities—and translate these into the work assigned and the performance expected.

This is easier said than done. We managers tend to get buried in paper and busy work. It is all too easy to let the work run us rather than setting our own objectives and work priorities—and a schedule of work that follows them. Isn't it logical that our highest work priority should be assigned to our greatest resource—the people who work for us?

How should we do it? First, take some additional time each day, even if it is only 5 or 10 minutes, to get to know better the people you supervise. And that doesn't necessarily mean working the longer hours. It may only require cutting out some unproductive work activity that now consumes your valuable time.

Once you really know your people, be sure that you and each person you supervise have the basis for a satisfying work relationship through the existence of the following:

1. A clear definition of the job.
2. Challenging and attainable work objectives. These should be specific, measurable and time-oriented. They should also be mutually determined in preference to those dictated by the boss.
3. An opportunity to review work progress—so that each person is measured not by vague personality criticism, but rather in terms of how well he attained these work objectives.

We managers in Government have a special advantage in the people area. That advantage is in having within our trust people with a special dedication to public service. The vast majority of them did not come to their jobs because they were in pursuit of the "fast buck." They are the right kind of people, and they deserve the best in terms of our supervisory behavior.

In every field of human endeavor, properly managed people eventually surpass their own past performances—jet transportation, the moon shot, and the 4-minute mile—just to mention a few examples. The present level of performance of our people is nothing more than the proverbial tip of the iceberg—insofar as their human capabilities go. The job of each of us managers is to reach each person we supervise. Turn him on! Then stand back, and watch him achieve new levels of performance.

SOLVING PROCUREMENT PROBLEMS

By DR. ROBERT C. SEAMANS, JR.
Secretary of the Air Force

MOST AMERICANS today are aware of the vital need to possess air superiority in any war in which we become involved. Through the combined excellence of well-trained pilots and good airplanes we have, for the most part, had this military advantage in World War I, World War II, the Korean War, and in Vietnam. Our dominance of the air, in fact, has been absolute enough to encourage the dangerous assumption that it will remain secure without any additional effort on our part.

But just as Sputnik startled our space people, the 1967 Domodedovo Air Show in Moscow clearly showed that the Soviet Union was challenging our air superiority. In response to the new fighters displayed there, the Air Force has asked for the development of the F-15. Cost proposals for this aircraft were submitted in August by Fairchild Hiller, McDonnell-Douglas, and North American Rockwell. By the end of 1969 an aircraft development contract will be awarded to one of these contractors.

On the surface, therefore, it is reasonable to say that things are progressing satisfactorily. But, in fact, the critical part of our task has hardly begun. The program will prove a success only as a result of the effective management of the acquisition process.

The Air Force will continue to undergo extensive public scrutiny concerning the need for the F-15. But analysis of the aircraft performances, cost, and the state of the art, should quickly persuade doubters that there is no alternative to procurement of the F-15, unless we are to expose our ground forces, our bases, and other aircraft to heavy air attack in future wars.

Public scrutiny of this program in other areas, though, may not be as easy to meet. Not that the program

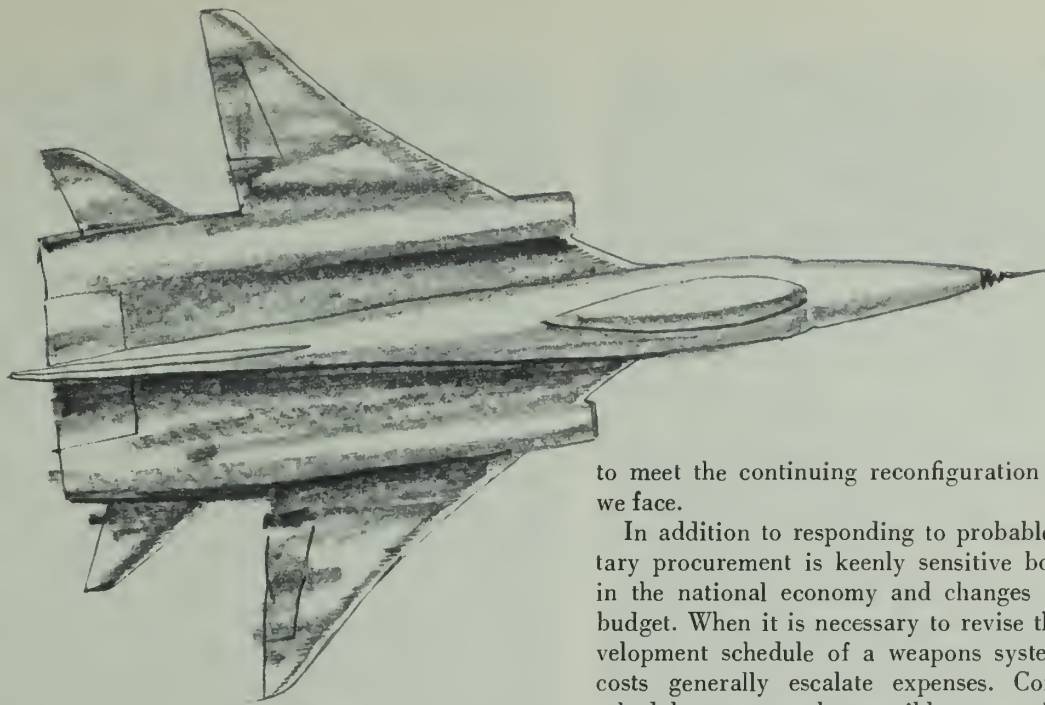
is indefensible in any respect, but rather because of the increasingly critical attitude of the public and the complexity of the procurement process. Management people, themselves, cannot always clearly explain such things as cost overruns. And, at a time when corporate expansions sometimes seem to be shutting out small business, discussions of the competition-negotiation issues are not always calm and reasonable.

Reviews of this sort are an essential part of the American system of checks and balances, and they make us in the Federal Establishment do our jobs better. Certainly, we cannot ignore the legitimacy of the host of demands made of the Federal budget. Logically, as the biggest single user of Federal funds, the Defense Department must be required to compete for them. This competition makes it imperative that management and procurement practices be exposed, examined and expunged of unnecessary complexities. One likely result will be the enlightenment of our citizenry concerning the unique difficulty of military procurement. This alone would be a worthwhile accomplishment.

Inescapable Procurement Realities

The entire procurement process could be greatly simplified if we were able to present industry with performance criteria that would not be changed, promise that we were firm as to the quantities to be procured, specify when we would require them, then go further and state that both our budget and our technical projections were unalterable.

However, given the circumstances under which military procurement operates, most of these goals cannot be fully attained. Much as the Air Force and industry might generally prefer straight line production goals,



both must accept the complex interaction of weapons system procurement with technological advances, international developments, changes in strategic concepts, and the determinations of Congress.

The desired characteristics of military systems frequently demand a quantum jump in the state of the art. In the commercial world this type of requirement is seldom laid upon large scale producers. Doubtless, that is one reason estimation of costs is far easier in automobile procurement than it is in obtaining weapons systems. Almost certainly a major reason for defense cost overruns is the need to plumb the future to acquire new technology in this age of rapid change, and to price those advances over such a long timeframe. Even though allowances may be made for exploring unknown technical fields, cost estimates sometimes collapse beneath the combined weight of new and old technical uncertainties.

Another vital difference between civilian and military production, or perhaps one should say *the* vital difference, is the penalty for gross error. In the case of civilian production, a corporation will probably suffer a loss, but even then advertising or repricing may allow partial recoupment. But in the event of gross error in military production, changes in national policy might well be forced upon us as a result of inadequate procurement of an essential weapons system.

Unless a nation maintains the flexibility to incorporate change swiftly into its weapons systems, it can easily fall behind other countries. This means, of course, an unavoidable increase in cost as changes must be made rapidly in existing systems. The alternative is to maintain regular phased development programs that will provide the necessary "new" products

to meet the continuing reconfiguration of the threats we face.

In addition to responding to probable threats, military procurement is keenly sensitive both to changes in the national economy and changes in the defense budget. When it is necessary to revise the planned development schedule of a weapons system, "invisible" costs generally escalate expenses. Compressing the schedule may not be possible even with greatly increased expense. And equally important, a stretchout of production from, say, 5 to 7 years, will also increase costs. Such stretchouts affect us in an inflationary period by reducing the purchasing power of the dollar below that which it was when development and procurement programs were laid out. Outright cancellations of complex systems, of course, represent significantly greater expenses since we must then dismantle the programed personnel/facility structure, receive no return at all for money spent and pay termination costs for material unusable in other systems. The circumstances requiring actions such as these are often beyond either anticipation or control by the individual Service.

Past Attempts To Solve The Problems

Those closest to military procurement recognize how unlikely it is that any single contractual process can successfully deal with the problems of defense procurement. In some instances, for example, it seems wise to have a price agreed upon, then let the manufacturer handle the risks and also the profits which may flow from improving his efficiency. It is improbable, though, that manufacturers would accept this type of arrangement if the product contracted for was extremely complex, costly, involved a lot of unknowns and extended over a long time period. In this instance industry probably could not participate unless the Government were willing to share in the risktaking.

Today, due to the consistent prominence of a few large firms, the extent of competition sometimes appears to have been narrowed. The beginnings of this narrowing of the competition cannot be dated precisely. Yet it probably began in the late twenties when the

military emphasis on high performance led to a divergence between military and commercial production. The large sums needed to finance the research and development basic to breakthroughs in performance made the military market inhospitable to all but the best-financed newcomers. And, for those companies which had grown up with aviation, the R. & D. emphasis forced them to choose between the less-risky and less-profitable commercial market and the more-risky, but at that time more-profitable military market. Those companies choosing the latter course had to maintain outstanding engineering staffs capable of exploiting technological breakthroughs. This led quickly to a situation in which one sector of the aircraft industry specialized in military products for both philosophic and financial reasons. Further specialization within this sector later resulted in concentrated purchasing when the Government found that only certain firms had the required engineering record and the R. & D. base for coping with specific performance demands. Present tendencies along those lines could have been predicted as early as 1937. During that year, the United States had 48 active aircraft producers. Yet all Navy procurement was with eight of these, and all Army procurement with 10. In fact "less than a dozen firms produced all but 200-odd of the 4,977 aircraft produced for the Army and the Navy between 1931 and 1937."

Through the years, in view of the concentration of military production in a few large firms, the Defense Department has made a studied effort to maintain competition. Though we were required to depend upon sole source purchases for about 23 percent of our procurement in fiscal year 1968, the remainder was made up of either price competition or technical and design competition.

However, inadequacies in the contract itself or the competition involved in the award can bog down the best of plans. For that reason, and to insure that the Government's objectives are not compromised, nor the manufacturer's freedom circumscribed, the Government has experimented considerably in an attempt to balance cost, performance, and delivery incentives.

In these attempts to come up with effective instruments our primary emphasis has been on the use of incentive type contracts. These have been designed to harness the profit motive, stimulate cost reduction, and lead to improved performance.

Present Attempts To Deal With "Intractable Procurement"

The Defense Department must seek the same sort of discipline that results from the profit and loss guidelines of the market place. Our contracts therefore must specify that both parties will be held to certain terms, terms which exert pressure and which exact penalties for failure to comply with the contract, but which also reward good performance. At the same time, our con-

tractual instruments must provide a degree of latitude to make design and quantity changes required by the national interest. In addition, the manufacturer must have the flexibility and incentives to innovate on both the technological and managerial fronts.

With respect to pinning down the terms of a contract, we must solve the problem of cost growth. In part, cost overruns have been confused with underfunding in the budgetary process. Budget requests have been based on a target price which was intended only as the low end of a range of possible costs. However, both the target price and the higher ceiling price were the result of negotiations and both reflected the expectation that final costs would end up somewhere between the two negotiated figures. Moreover, extreme competition between contractors sometimes led to very low target prices. And within the services, competition between programs for scarce dollars had a similar effect.

In the future, we must improve our cost estimates within the services, and make it clear to manufacturers that realism in cost estimates will be a major consideration in source selection. Adequate recognition of the effects of inflation would also make a lot of our estimates look better. For instance, estimates made 5 years ago are up about 25 percent in terms of current dollars due to inflation in the cost of aircraft production.

Program changes are another factor in cost overruns. If we do our homework thoroughly, we should



From F-15 to Bricks—The author examines an item at the lower end of the complexity scale—the common brick. Sgt. Perry J. Taylor of Los Angeles tells Dr. Seamans how bricks are hand-made at the 820th Civil Engineering Squadron's (Red Horse) brick plant during the Secretary's recent visit to Tuy Hoa Air Base, Republic of Vietnam (7AF).

not require extensive changes. By improving our definition of operational performance objectives, we can come up with better product definitions before we enter development. In the past we have sometimes hurried through the product definition phase in order to speed full-scale development. This has subsequently led to frequent changes, expensive changes which might have been avoided in many cases.

Essentiality might well be the keyword in both improving product definitions and determining necessary changes. Too often we have encumbered our weapons systems with features that were "desirable" but which did not match their great cost with equally improved performance. On this point, changes need also to be measured against the yardstick of total program cost. Unless this is done, and judgments are made against that fiscal background, a change can get out of hand and end up like a financial tail wagging the entire weapon system. It does little or no good to produce a system remarkably advanced but prohibitively expensive. Some changes will remain necessary, but they must be made with a keen awareness of the cost impact on the total program.

We must also provide for better management of our programs after contracts have been negotiated. During his 1968 presidential campaign, President Nixon said: "I intend to initiate a major reorganization of the Department of Defense to correct its overcentralization and streamline its top level overstaffing." This type of reorganization is taking place today throughout the Department of Defense. It is critical if we are to maximize the Nation's return on investments in manpower and money. Unless we are willing to stifle the drive and creativity of our lower echelon personnel, we must grant them the freedom which follows from clear delegations of authority and responsibility.

It is a rare manager who cannot recall numerous occasions when he was tempted to "help solve" nuts-and-bolts issues at lower levels in his organization. Yet this is exactly the sort of interference that can hamper effectiveness.

I strongly feel that the Systems Programs Office (SPO) should be held responsible for the proper conduct of programs assigned to it. We must select good men to manage the programs, then give them a chance to do their job. We must restrict the contributions of both Headquarters AFSC and Hqs USAF to major policy issues. This should produce a climate favorable to innovation and flexibility. It should also free senior management staffs for their proper functions.

As a tool for both the Program Director and higher review authorities, the F-15 procurement contract will incorporate a series of well-defined and demonstrable milestones to measure the contractor's progress. The milestone concept should allow us to assure that the contractor has actually accomplished the development agreed upon at certain points in time and cost. In the

event the required progress is not attained, we will then be able to adjust schedules, thereby reducing the overlap between the engineering and production phases which has caused so much difficulty in the procurement of other systems. The milestone approach will also allow us to avoid committing large sums to production without the quantitative data which development and test programs should provide.

To make sure that the Air Force and the contractor base their decisions on similar information, the Air Force now incorporates the Cost Schedule Planning and Control System (C/SPCS) in major weapon systems contracts. Through this means the information used by the contractor in the management of his plan, and in generally measuring performance, can be fed directly to the Systems Project Office via the Management Information System.

The F-15 contract will have three major parts: Part 1, design, development, test and redesign; Part 2, aircraft and hardware required for a testing program; Part 3, production of the first wing of aircraft and associated training equipment. Part 1 will be negotiated on a cost-plus-incentive-fee basis. Hoping to insure basic technical objectives, encourage innovation, provide flexibility and avoid subjecting the contractor to the catastrophic risk possible when working in the unknowns of major developments, we shall prenegotiate a cost-sharing arrangement containing minimum and maximum fees. Performance in designs, structures, components and subsystems will be gauged against contractually agreed-upon milestones.

Parts 2 and 3 of the contract will be written on a fixed price incentive basis. This will take into consideration, the possibility of upward revisions of contract costs based upon previous cost experience. However, a ceiling will be established beyond which costs will not be reimbursed. For such points as first flight and fatigue tests the demonstrable milestone approach will continue to be used. Contract language is now being developed to specify sanctions for failures to meet the latter.

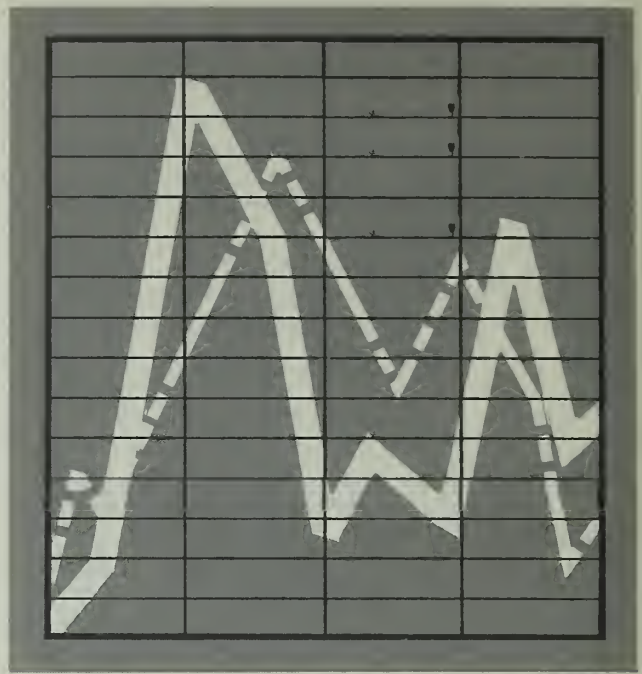
No Panacea for Procurement Problems

We cannot effectively fight wars with equipment that does not meet the military demands of the moment. Neither can we meet the procurement demands of today and tomorrow by operating with outdated means. On the other hand, equipment must not be so expensive that we cannot afford it. Innovation and flexibility are as necessary to this function as they are to any of the areas vitally involved in the defense picture. The complexity of military procurement defies application of a simple set of rules. None have been found. In their place, instead, we must rely on hard, continuing study of changing circumstances. The challenge of coming up with the proper combination of discipline and flexibility to deal with these will always be with us. □

AN ESSAY ON THE PROFIT MOTIVE

This paper is a skeptical discussion of the motivational functions of profit in business affairs. It suggests that traditional conceptions (and the procurement policies based on them) have over-emphasized the role of profit in operational decisionmaking and questions the existence of a profit "motive," relating profit to the concept of "hygiene factors."

—Author



A GROUP of us at Buffalo has been engaged in wide-ranging studies of so-called "extra-contractual" influences upon contract performance.¹ Focused mostly in aerospace R. & D. environments, our work has involved searching interviews with hundreds of management-level people representing varied functions in a large number of governmental and industrial organizations. One feature of our efforts has been an interest in shedding additional light on the role of profit in business decisions.

Data from our interviews, and from divers other sources, are presently being analyzed statistically and will be reported fully in the future; but, for now, drawing on preliminary findings and on impressions gained from over 2 years of work, we at least can essay some general statements about the motivational functions of profit and at the same time sketch the tentative outlines of an evolving "theory" linking it to other influences upon organizational performance. However, it will be

¹ This work has been supported largely by a grant from NASA (NGR-33-015-061). Together with the author as Project Director, F. A. Perry, Jr., Ira S. Rubin, Stanley Fong, and John P. Seagle have been principals in the research. Thanks are due to Richard P. White, Special Assistant for Pricing to NASA's Director of Procurement, for his careful reading of an earlier draft of this paper and for his efforts (probably futile) to save it from fatal error.

By DR. RAYMOND G. HUNT
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useful if we first indicate just what we mean by "motivation" and say something, too, about how we regard the government procurement context to which we propose to extend our motivational analyses.

The Government Procurement Context

We have found it convenient to view the working relations between government procurement agencies and their contractors as a single interacting performance unit or system. To be sure, the parties to it retain separate identities, but our model's general premise is that, although task-relative and perhaps temporary, the agency/customer and the contractor operate in a functionally interdependent manner² such that outputs from their interaction reflect characteristics of the two separate parties melded with emergent properties of their relationship. Therefore, since our task is to understand as much as we can about how this system works, we have attended to the mutual and reciprocal influence patterns manifest in the system and the ways they impact its decisions and control its outputs.

Motivation

We construe motivation essentially within a decision framework.³ That is to say, motivation has to do with those varied processes affecting choices from among an array of alternative actions. This conception is as applicable to collective (organizational) actions as it is to individual decisions, but, as we have pointed out elsewhere,⁴ the analysis of organizational motivation is plainly more complex, involving as it does the interacting operation of both individual and organizational influences.

Our view of motivation is also a dynamic one. We postulate that any "hierarchy of motives" will tend to shift with changing circumstances. We also posit that

² Some features of the patterning of these relations have been discussed in Rubin, I. S. and Hunt, R. G. *Some aspects of managerial control in interpenetrating systems: The case of government-industry relations*. Technical Report No. 7, NGR 33-015-061, Buffalo, N.Y., State University of New York, July 1969.

³ A fuller, although still provisional, statement of our motivational conceptions may be found in Hunt, R. G. *A general model for motivational analyses of exchange relations*. Report of Progress, NASA Grant NGR 33-015-061, Buffalo, N.Y., State University of New York, 1968.

⁴ Hunt, R. G. and Rubin, I. S., *Individual and corporate sources of motivation: A preliminary investigation*. Technical Report No. 3, NGR 33-015-061, Buffalo, N.Y., State University of New York, March 1969; and Hunt, R. G. Corporate, individual and situational factors in organizational motivation. Address before Orange County, California Chapter, NCMA, March 12, 1969.

"We have found monetary return to be regularly outranked in lists of corporate goals by such objectives as efficiency, meeting the competition, producing quality goods, and the like."



Dr. Raymond G. Hunt

similar actions can be differently motivated, that different actions can be similarly motivated, and that the same action can be differently motivated at different times. Finally, we have argued that a given motivational influence can be ranked, "on the average," at the top of some abstract motivational hierarchy and yet *never* actually be the paramount determinant of any concrete decision! Indeed, for reasons we haven't the space to enumerate here, we suspect this may be the case with profit. At any rate, after this preamble we can return to explicit discussion of that topic.

The Role of Profit

Possibly an anecdote can render less abstruse what we have been saying and at the same time clarify the point of the discussion that follows: When seeking voluntary participants for our research our practice has been to include along with a letter of inquiry a complete description of the project and our procedures, together with samples of all questionnaires and topical interview outlines. This turns out to be a pretty formidable looking package, but our purpose in sending it was to guarantee understanding of just what participation in the study entailed. After reviewing our plans and procedures, one corporate contracts manager politely observed that he could see no reason for becoming involved in so elaborate an exercise as ours when, after all, he could provide the fundamental answer to our "contracting and motivation study" in one concise sentence: "The motivation of business is to make a profit, period!"

If blunt, our correspondent was also gracious and consented to discuss the matter with us. With particular reference to his assertion we talked about such things as trade-offs, long terms and short terms, other business "interests" and contingencies, etc., and it soon became evident that, without gainsaying the importance of profit in business affairs, real day-to-day business decisionmaking and hence contract performance tend to be rather more complex than over-simplified allegations about "monolithic profit maximizing" would have it. (As an aside, it might be noted that the company eventually decided to participate.)

Now, it goes almost without saying that in a modern exchange economy businesses need money (or its equivalent). As we all know, they need it for many things: to pay bills, to meet payrolls, to build buildings, to advertise their wares, etc., etc., etc. But what of profits? Do they need profits and, if so, why?

Well, since businesses *need* money it seems reasonable to assume they will endeavor to assure its availability. Furthermore, one can surely agree that it is only prudent to keep a monetary hedge against a financial rainy day and clearly wise to maintain a fiscal capability (whether in the form of a "reserve" or an ability to attract capital) for seizing "opportunities" as they come knocking fleetingly at the corporate door.

Plainly, a firm's ability to take in more money than its current costs of operation is a useful attribute, at least it is if it hopes to survive over the long run.

That profit has some sense behind it is thus obvious (even philosophers of the left can grant that); but how much is needed and when? The only rational answer to those questions, of course, is: "It depends." It depends (at minimum) on how much money is needed at a point in time in ratio to the amount of cash on hand.⁵ But, because such ratios can rarely be accurately forecast, prudence once more suggests that the higher the level of profits that can be made *now*, the fatter the cushion and the safer one can feel about the future.

Money vs. Profit

We have gone through this elementary disquisition and have ignored some technical differentiations in conceptualizations of profit, for which apologies are doubtless in order, so as to make a vital, but easily overlooked point: Whether a business *needs* profits is necessarily uncertain, but for that very reason, it will tend to *want* all it can get. The implication of this observation is that while *money*, per se, is an indispensable means of accomplishing business objectives in an exchange environment, *profit* functions principally as an "uncertainty reducer;" it (or its anticipation) allows for greater tranquility and confidence in facing the future and the unpredictable threats it may bring.

Profit and Uncertainty. As motivational influences, then, money and profit have quite different statuses. Whereas money is a daily operational requirement, profit can be said to be "needed" only in proportion to the degree of financial uncertainty facing the firm. Admittedly this is a somewhat vague notion, but one can, for instance, easily imagine concrete conditions that can bring about reductions in uncertainty with corresponding reduction in needs for profit (although, the magnitudes of reduction might be hard to estimate). In a government contracting environment, for example, progress payments have this effect, as, more generally, does monopolistic status. Many other illustrations will come quickly to mind; the point to be appreciated is that means other than profit exist for reducing uncertainty. Therefore, "factors" exist that can substitute for profit.

For instance, while risk and general requirements for resource utilization are of primary importance in gaging profit guidelines, the respondents in our studies frequently gave ample evidence of willingness to trade profit for other benefits that might accrue to them from work in which they might be engaged, however "risky" the work or demanding of shortrun resource utilization. In fact, we have found "monetary return"

⁵ Entering into consideration might also be interests in providing for future contingencies (e.g. "unk-unks") or supporting long range organizational plans.

to be regularly outranked in lists of corporate goals by such objectives as "efficiency," "meeting the competition," "producing quality goods," and the like. Moreover, we have developed data suggesting that a decline in *sales* tends to impact priorities among corporate goals more than fluctuations in profits.

Profit and Risk. In a different terminology it might be said that needs for profit vary with risk. Indeed, this idea is commonplace and is explicit in such as the Weighted Guidelines. However, from a motivational perspective such formulations can be seriously misleading. Risk in the short run (say, in reference to a particular contract), even if it can be measured (which is often doubtful) is relevant in a motivational sense only to the extent that it somehow impacts (or is perceived to impact) longer term *net* uncertainties (i.e., the firm's ability to sustain itself into the future). Only when construed thusly is risk a pertinent concept for motivational or decisionmaking analyses (a fact that, combined with difficulties in assessing degrees of risk, calls into serious question the utility of the Weighted Guidelines as profit criteria).

But to continue the main thread of the argument, it is evident that needs for profit vary with circumstances contributing to uncertainty. In brief, if there were no uncertainty presumably there would be no need for profit.

But, of course, there is uncertainty, notwithstanding occasional imputations to the contrary in government prime contracting.⁶ So at least some profit is necessary and will be sought by business organizations. Having said that, however, in no sense resolves the question of just how profit considerations work to influence business decisions; put differently, it does not clarify the motivational status of profit.

We have tried to show that, albeit loosely specified, other things can substitute for profit and that needs for profit can vary, presumably from intense to nearly nil. By implication, then, it should be possible to translate profit units into other units and conversely, an operation that would allow statement of any motivation in terms of dollar equivalents. However, the "exchange rates" would have to include suitable situational constants. Thus, even leaving aside measurement problems, a quite complex calculus would be needed.

Perhaps these complexities explain the eagerness with which otherwise sophisticated people opt for sim-

plistic solutions to questions of business motivation, solutions such as the doctrine of monolithic shortrun profit maximization. Moreover, because almost all government contracting policies and methodologies are grounded in this doctrine they can only be regarded as singularly naive despite their frequent technical elegance.

Models vs. Reality

Needless to say, it would be convenient were the world actually so simple as this doctrine paints it.⁷ Yet it clearly isn't (and, in truth, everybody knows it isn't). How such myths retain their vitality is marvelous to contemplate. Of course, one obvious reason for it is the absence of any satisfactorily comprehensive alternative; but it seems likely there is more to the story than that. That "something more" very possibly constitutes a classic illustration of what philosophers of science describe as confusing a *model* of reality with the reality it models. What we mean is this:

Back in the year one (perhaps a little more recently) some astute economic analysts, hoping to make sense of business behavior, decided that in its natural state it was all very complex and bewildering and so needed simplifying. They couldn't do everything at once anyway, so they wisely decided to make some assumptions which they could take as "givens" about certain parts of the whole and then take it from there and see what happened.

As a starter, they assumed that business decisionmakers are always perfectly *rational*; they never do "crazy" things or go against the grain of the evidence. As for the evidence, further assumptions got made to the effect that *all* the relevant evidence was at hand, and that it was *understood*. But just having the evidence and dispositions toward rationality isn't enough, decision rules are needed for its use. So, to make it easy on him (and us too), our storied decisionmaker was equipped with a single, universally applicable rule: maximize gain—always choose that alternative that will result in the greatest immediate return to the firm.

Thus, by a succession of simplifying assumptions—by the process of building an analytic model—flesh and blood decisionmakers were converted into figurative machines (or, if one inclines to a more dramatic metaphor, gods); into omniscient, perfectly rational profit maximizers (which, by the way, presumably also

⁶ In this connection it is worth noting that even if it were true that no uncertainty exists in government contracting, firms would doubtless still have an "interest" in profit, if not an immediate "need" for it. This arises from the fact that profit serves as a buttress to a contractor organization's independence and freedom to seek alternatives whereas "cash-flow" guarantees, if comforting, would tend to have precisely the reverse effect. Therefore, it is even arguable, although we haven't space for it here, that much government-industry discussion of profit and ancillary matters amounts, in effect, to an elaborate negotiation not only of particulars of allowable profit rates but, more importantly, of broader terms of the contractor's independence and contractors have an "interest" in that.

⁷ Obviously, if the "calculus" alluded to earlier existed, one could employ it as a means of making things conform to the doctrine in a practical sense. But, in any case, that would require detailed knowledge about other motives; in addition, it makes a staggering array of assumptions about the scales of values involved in motivational measurement. And all of this says nothing about other dubious assumptions entering into contracting methods, such, e.g., as the ideas that contractors make their decisions on a contract-by-contract basis or that, over their life spans, contracts, per se, can control performance.

have as much time for decision as is "necessary"). Once stated in basic form, this model was available for elaboration and could be taught in school with great plausibility, elegance and frequency. Gradually, however, its assumptions have apparently ceased to be thought of as assumptions and have widely achieved the status of revealed truth.

Yet, plainly, the conditions under which a businessman *could* function as a "pure profit maximizer" can be met rarely, if ever. Furthermore, it isn't even clear that he *wants* to be one, although the model seems to have become so thoroughly ingrained into the "conventional wisdom" and the "moral code of the businessman" that he commonly believes he *should* want to, feels compelled to *act* as if he does and, like Hamlet's mother, talks about it incessantly.⁸

Profit as a "Hygiene Factor"

But, if he doesn't want to be a pure profit maximizer, what does he want to be—what are his motivations? Certainly he wants to be a *profitmaker*, both for reasons we've already mentioned and because it's a way of measuring performance. We have also implied here the broad thesis that he is very much an uncertainty reducer (as are all of us), strongly oriented toward the "maintenance" of his enterprise. But, in fact, he wants a lot of specific things too: a chance to build airplanes, maybe; power; yes, and such things as opportunities for social and community service. Moreover, when we've asked about it, "performing effectively" and having "opportunities for self-expression" have usually received higher ratings than such alternatives as maximizing income. However, the question at issue now is not what other motives may exist, but the status of profit and profitmaking in the motivational scheme of things.

Actually we perceive it as serving a variety of personal and organizational functions, most of which reduce to something like what Frederick Herzberg, in another context, has called "hygiene factors."⁹ What we postulate is that under a *set of specific assumptions* (the nature of which we've hinted at here) profit serves as a necessary condition to the survival of the enterprise and so serves to "motivate" business decisions only in its relative absence. Moreover, its contributions

⁸ There is, of course, a contrary morality that may have something to do with this. As Talcott Parsons has put it, "*** money return is a primary measure and symbol of success and is thus part of the goal structure of the organization. But it cannot be the primary organizational goal because profitmaking is not by itself a function on behalf of the society as a system." (Suggestions for a sociological approach to a theory of organizations—I. *Administrative Science Quarterly*, 1956, 1, p. 68.) One could speculate that by sheer vocal insistence, overemphasis and sloganeering some businessmen may strive to legitimize what they otherwise somehow suspect may be a morally dubious concept.

⁹ Herzberg, F., Mausner, B. and Snyderman, B. *The Motivation to Work* (2nd ed.) New York: Wiley, 1959.

to the decision process probably have more to do with its *strategic* aspects than with its tactics. Day-by-day decisions are controlled mainly by other than profit considerations, although it may be necessary that such decisions satisfy broad decision rules or screenings designed to avoid excessive overall erosion of profit margins.¹⁰

Our most general hypothesis would be to the effect that business decisions are taken mainly with an eye toward satisfying an admixture of concerns with survival, growth, control, and uncertainty reduction. In short, if there is a central thread to business decision-making—a basic motive—it is not profitmaking, much less profit maximizing, but rather it is something that might be called *mastery* or what the psychologist R. W. White, in speaking of individual motivation, has called competence.¹¹ Briefly, we propose that in the interests of survival¹² the business enterprise is chiefly oriented toward mastery in its own house and control over its environment so that it can organize its affairs and minimize unplanned contingencies or at least maximize its ability to meet them with a minimum of disruption. Profit, along with other expedients, is a means to that end, not an end in itself. Growth, in size and scope, has much the same function. To the extent that size or diversity carries with it power over or insulation from the vagaries of the "market," it serves to reduce uncertainty and so can be alluring.

Having said this, of course, lays bare a further, enormously intriguing question; viz. why should businessmen care about the organization's survival? What motivates *people* to pursue their (i.e. business) interests? This is a subject for another paper, but, just in passing, we suspect that it has to do chiefly with the acting out of organizational roles. In other words, a good part of organizational motivation, we believe, has its roots in "demands" of the jobs people occupy and the relative dominance of organizational subsystems. Oversimplified, this means that fiscal managers, in the nature of their jobs, are concerned mainly with money, profit, etc. Engineers, on the other hand, may be differently bent. The more the former dominates the latter in a given organization, the more will it tend to be "profit-oriented" or vice versa. People, in other words, do what they want to do, but what they want to do often has at least as much to do with positions they occupy as it does with their "personalities." It will be understood, of course, that, for the present, this, like much of the rest of this paper, is an hypothesis, not yet a fact. □

¹⁰ To be sure, none of this implies the nonexistence of avaricious businessmen or "profit-hungry" organizations. It only asserts the inadequacy of such images as a basis for general model building.

¹¹ White, R. W. Motivation reconsidered: The concept of competence. *Psychological Review*, 1959, 66, 297-334.

¹² Throughout this paper we have used the notion of "survival" after the fashion of J. K. Galbraith's *New Industrial State*. Boston: Houghton Mifflin, 1967.

MILITARY CONSTRUCTION APPROPRIATIONS

Are We Planning Right and Building Enough?

WITH MORE than a quarter of a century of association with military construction behind me as a member of Congress, I hold views on this subject which I must admit are strong.

For instance, I consider the low levels of military construction recommended to Congress each year by OSD to be deplorable. In this field, we are dealing largely with permanent military bases. We are seeking to provide adequate training, living, working, and storage facilities. The level of requested appropriations is never more than half the amount needed for replacement and modernization and is usually much less.

Facilities Outmoded

The Services are required to make do with many inadequate facilities or facilities which were not designed for present day purposes. Some are temporary World War II structures which have long outlived their usefulness. Maintenance is far behind desired levels. And housing of all types, which for our purposes should be comfortable, adequate, and pleasing, is sometimes disgraceful. It can scarcely be said to improve morale and encourage retention.

Military construction gets what funds are left at the bottom of the barrel after other military needs have been provided for. The military construction request

By CONGRESSMAN ROBERT L. F. SIKES

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now before Congress calls for authorization and appropriations of \$1,222,882,000 and, in addition, it would provide 4,800 units of family housing. This is, by all standards, a very small program. Only \$380 million of this amount is for modernization. If the entire job of modernizing base facilities to present day accepted standards were undertaken in a single year, the estimated cost would be \$8.2 billion.

This is not a happy circumstance, nor is it a necessary one. The United States is far too prosperous a nation for this situation to be tolerated. The big segment of our population who are in uniform or who are military dependents are in reality being neglected. Not enough voices are being raised in their behalf.

Spotty Follow-Through

Fluctuations in the implementation of military construction programs have for a number of years contributed imbalances almost as bad as the low level of recommended programs. We have had instances in recent years where major parts of construction programs have been deferred by OSD directives, after approval by Congress and projects, when finally built, have suffered from inflationary trends which now are an inevitable part of the American scene. This necessitated cutbacks in the level of construction, and in quantity and quality of the scheduled projects.

It was suggested by my good friend Barry J. Shillito, Assistant Secretary of Defense for Installations and Logistics, that an article by me as Chairman of the Subcommittee on Military Construction of the House Committee on Appropriations would help to emphasize the concern that Congress has in fostering management improvement and cost consciousness in the Department of Defense.

On the former, yes; but on the latter I suggest that the minimum programs offered insure, by their small scope, adequate cost consciousness. So let us look more closely at management improvement, which in its complexity offers room for many discussions such as that encompassed in this paper. I shall touch on but a few key points.

Poor Planning

Let me turn first to future planning, which for a time I felt was extremely shallow. Fortunately, this is not now generally the case. Let me give an illustration of better than average planning. I recently queried the Army on the existence of a program to avoid being caught in the next war without quickly available port facilities. One of the worst problems to arise in the 1965 buildup of forces in Vietnam was lack of port facilities. Billions—literally billions—were wasted as ships waited in inadequate harbors for months on end to unload cargo which was desperately needed by United States and South Vietnamese military forces.

One source of relief was transportable piers which were built, then floated into place and anchored. A number of these are now available for storage for future emergencies. The Army recognizes the problem and is planning to store floating piers for emergency use. Gen. Frank Besson in the Army Materiel Command and his successor, Gen. Ferdinand J. Chesarek, have shown cognizance of the magnitude of this problem. In the next war it can hardly be expected that our ports and harbors will be spared from aerial or missile attack. Such attacks would have compounded the Vietnamese problem many times over. With this knowledge, it would be inconceivable if realistic port planning were not included for the future, but let us be thankful that this is not the case.

Nevertheless, I am not convinced that the overall long-range planning picture has been thought through in depth. This was stressed by my committee as early as 1966. Frank Sanders, Assistant Secretary of the Navy, was then a staff member of the House Committee on Appropriations and did valuable work on this subject. Here is what a committee report on the fiscal 1967 military construction bill stated:

"It is notable, however, that in the mid-1960's, despite the lessons of World War II and Korea, we seem to be but little nearer to a coordinated preplanned method for the construction of emergency military requirements than during those conflicts. It is disturbingly similar to a trial and error process. The problems in the construction effort in South Vietnam, as they relate to coordination and management, point up the necessity for an in-depth study by the Department of Defense of the construction organization best suited to meet the defense needs of the country. The committee calls upon the Department to take steps to initiate such a study, which will give consideration to construction requirements of the Department both in normal peacetime activities and during the exigencies and emergencies of war. The question of whether or not the present structure relating to the construction and engineering functions of the Department of Defense is a proper and valid one for a modern defense force can no longer be ignored and must be made a matter of intensive and in-depth study by the Department."

Southeast Asia Experience

In the hearings on the fiscal 1968 military construction program, it was found that the Department of Defense had done little in an overall way to implement this directive. Rather than initiate a study on the overall problem, the Department directed its efforts toward Southeast Asia. This, of course, should have had number one priority because it was still our number one construction problem. However, the Department of Defense should be interested not only in emergency type efforts, such as Vietnam, but in basic procedures for the

coordination and management of the entire military construction and facilities program as a part of a long-range program. The latter continues to need more emphasis, particularly as the magnitude of military construction problems in Vietnam diminish.

The experiences gained in Southeast Asia can serve as a steppingstone to an in-depth study to determine the construction organization best suited to meet our defense needs. It appears that some additional progress is being made in this matter, but it is far from certain that the Department looks upon the problem as seriously as does the House committee. Such a study, if properly handled and implemented, should be a major contribution to the defense effort of the United States in future years.

New Planning Outlook Encouraging

I take encouragement from testimony accompanying this year's military construction bill which indicates a more careful look at continuing and future requirements of on-base facilities by the services.

This is pointed up by testimony from Lewis E. Turner, Deputy Assistant Secretary of the Air Force, who stated:

"We now have underway within the Air Force, actions to develop a balanced long-range construction program. Under this program, an annual increment of replacement and modernization facilities has been phased over a 10-year period. Major emphasis is placed on acquiring those facilities which will secure the timely readiness condition of our installations to support the forces scheduled during the next 5-year period. Planning our total replacement/modernization requirement over a 10-year period will permit the establishment of a stabilized annual construction program level instead of the widely fluctuating annual program totals experienced in the past.

"Our \$17 billion facilities inventory (with an estimated replacement cost of \$36 billion) still contains many deteriorated World War II buildings in everyday use. Many Air Force personnel live and work in obsolete, inefficient, inadequate buildings that are difficult and expensive to maintain. Faced with this situation, it obviously is false economy not to replace or modernize such structures at the earliest possible date. Reductions in annual appropriations for facility maintenance, combined with the inability to secure funds for replacement by new construction, compound this serious problem and result in accelerated deterioration and higher ultimate costs. Our 10-year program plan is designed to provide a practical and economically feasible solution to this long-standing problem. We are encouraged in this regard by the OSD support of more realistic long-range planning and programing consistent with the committee's views."

This is not the same as long-range planning for emergencies. It is an extension of planning over a longer

period for current requirements. This is an important step in the right direction. Both types of planning are, of course, essential and the two should go hand in hand.

Maintenance Neglected

Let us now look at the maintenance of real property. Here, for all the discussion it receives, is still a seriously neglected problem. Deferred maintenance is growing year after year and the result inevitably is reflected in bigger bills to the taxpayer. When money is tight, and it always is in this area, maintenance is something that can be deferred when other programs apparently cannot. The total of deferred maintenance for all the Services now is estimated at \$555 million.

The Committee on Appropriations has for many years been urging that the Military Services properly and adequately maintain the extensive real property holdings within their jurisdictions. Some 15 years ago this interest was manifested in the appropriation of funds above the budget estimates for the backlog of deferred maintenance.

During the ensuing several years it became apparent that moneys justified to the Congress for the maintenance of real property facilities were being diverted to other uses in the absence of any restrictive law or legislative history. In consequence, in recent years, the committee has recommended, and Congress has agreed to, language in the appropriation acts establishing floors or minimums in the amounts of money which must be devoted to real property maintenance. In the appropriation act for the fiscal year 1969, for example, the language reads for the Navy:

"* * * of which not less than \$155,600,000 shall be available only for maintenance of real property facilities, * * *"

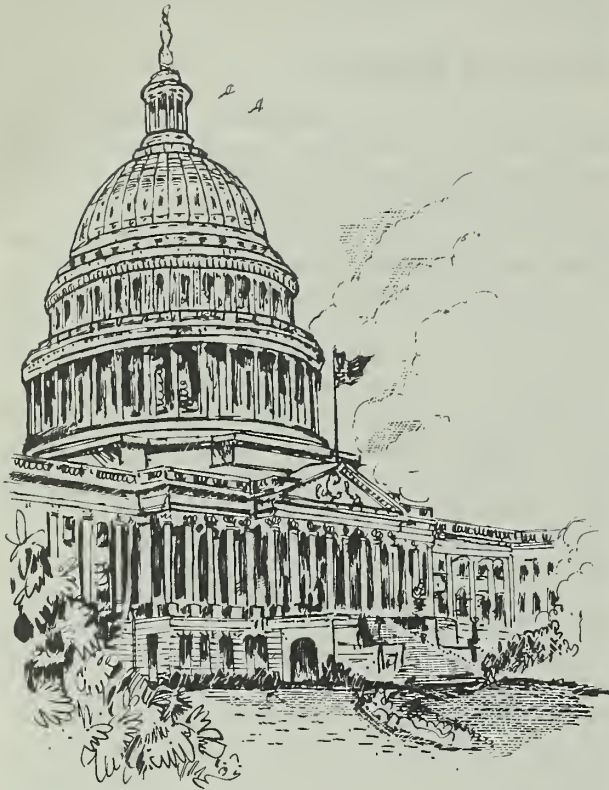
In case of the Marine Corps, the language read similarly:

"* * * of which not less than \$22,661,000 shall be available only for the maintenance of real property facilities."

"Congressional Intent" Misconstrued

House Document No. 91-50 from the President, earlier in 1969, proposed revisions reducing those amounts. Testimony in the hearings on the Second Supplemental Appropriation Bill indicated that reductions were made in the floors on real property maintenance based on "congressional intent." It appeared from the testimony that this interpretation of congressional intent was based on the Revenue and Expenditure Control Act of 1968 and its effect on Government expenditures generally.

It would seem to me that we have here a situation of ignoring, or violating, congressional intent. The ef-



fect, of course, would simply be to aggravate the problem of deferred maintenance.

I should like to point out that the Revenue and Expenditure Control Act of 1968 was enacted into law on June 28, 1968, Public Law 90-364. While its terms and conditions allowed some considerable flexibility in the executive branch, there was not in connection with its enactment—at least to my knowledge—any discussion of an intent to cut back on the maintenance of real property facilities of the Department of Defense.

Now I would like to point out that the appropriation bill for the Department of Defense for the fiscal year 1969 contains as a matter of law phrases such as I have previously quoted. I do not believe it likely that the Department can find a shred of evidence in the debate or in the committee reports on the Defense appropriation bill indicating that the language of the law on maintenance was intended to be set aside by any assumed or presumed interpretation of congressional intent stemming from the earlier enactment of the Revenue and Expenditure Control Act of 1968. On the contrary, it could be presumed that the enactment of the floors on maintenance of real properties in specific numbers and at a later date indicates the precise opposite, namely, that it is the intent that such an amount must in fact be expended for the purpose.

I do not wish to magnify this incident out of all proportion. I stress it only to show the strong interest of Congress in an adequate level of maintenance. When this is not done, it is safe to say that the taxpayers of the country have to shoulder the burden of new construction prematurely or unnecessarily because of failure to adequately maintain facilities that are now in being.

The Military Housing Challenge

Now, let us look briefly at the overall picture of family housing, where it is time for bold new concepts. There should be stress on attractive new designs. Folio or garden type housing is an abomination which never should have been inflicted upon military families and should be discarded.

The Services should be encouraged to abandon the red tape which now circumscribes family housing programs and to enlist the interest of contractors who have demonstrated that they can build sound and liveable and attractive homes. In the one or two instances where this has been done, substantial savings have been realized and the quality of the product is said to have been improved.

A new program utilizing leased housing is needed. The Services should recognize the potential which is offered in this field. They have procrastinated for years on a recommendation to Congress for authorization to institute a program for the construction of rental units for lease to military families by private owners.

Overseas, there is equal need for initiative and boldness in providing family housing. The rental guarantee program has been a slow starter. After years of effort it is barely getting off the ground and offers little promise that it can ever be a truly effective means of providing homes for military dependents. A new concept, a lease-purchase plan for housing to be built on Government property, will be undertaken this year as a result of authorization being requested from Congress to encourage the use of private funds for construction. It appears to offer the means of providing houses in those areas where the rental guarantee method has failed and should be fully explored. Of coincident interest in the new housing concept is the possibility of using the commodities exchange program in part payment. This could be of great value to our country which nearly always has a surplus of agriculture products. The new program offers an opportunity to reduce gold flow, an equally significant consideration. The House of Representatives already has given its approval.

Proportionately Less Spent Today

Finally, let me comment on the now prevalent furor over military expenditures and to emphasize the obvious fact that we have never spent too much on military construction. Those who are genuinely interested in the

well-being of American families should not overlook the fact that the needs of many of the families of those in the uniformed services are being neglected to an extent as great as any in civilian life.

To those who wish to direct efforts for reductions in expenditures primarily toward the military, let me point to the fact that, taking into consideration the Vietnamese war and the higher costs of defense due to wages and inflation, we actually have the smallest level of defense spending we have had in years. Defense spending without these added factors is less than it was in the early 1960's, in times of comparative peace. As a result of this situation, badly needed modernization of ships and aircraft has been delayed for several years. Construction of on-base facilities has had to take more than its share of the reduction. This is a dangerous delay which is becoming more aggravated with each passing day.

The Russians have not made a corresponding reduction in their level of defense. They spend approximately twice as great a percentage of their gross national prod-

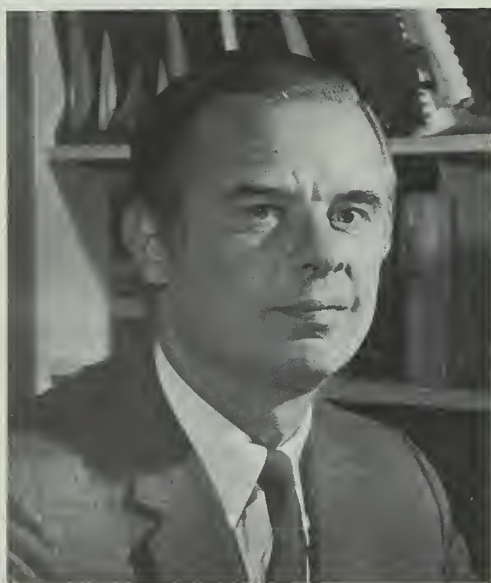
uct on defense as we do. They are spending about as much in dollar value as we spend, and Russia, by virtue of lower wages and tighter control of inflation, gets more for a defense dollar than we do.

Adequate Construction A Joint Responsibility

I have attempted to state that there is a vital need for a more adequate military construction program, which is based around sound planning and supported by proper maintenance. It is equally important that long-range planning for military contingencies take into account the lessons learned in warfare of the present and that projected for the future. In all of this, Congress and the Department of Defense share a joint responsibility. The primary burden is on the Department of Defense, but Congress should give full support where support is justified. There is need for constant and sympathetic cooperation and both should accept their responsibility not to stint where America's safety or the well-being of uniformed personnel are concerned. □

We ought never to forget that true public economy consists not in withholding the means necessary to accomplish important national objects confided to us by the Constitution, but in taking care that the money appropriated for these purposes shall be faithfully and frugally expended.—James Buchanan

PARALLEL UNDOCUMENTED DEVELOPMENT



By **RALPH C. NASH, JR.**
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IN THE SUMMER of 1968, the Subcommittee on Antitrust and Monopoly of the Senate Judiciary Committee conducted hearings on the subject of Competition in Defense Procurement. These hearings were exploratory in nature, with a number of commentators on Government procurement being asked to contribute their thoughts on the adequacy of competition in defense procurement. In my testimony, I suggested that weapon system procurement could be significantly improved if the development phase were conducted by contractors in parallel with significantly less documentation being required. For the sake of simplicity, this technique was called Parallel Undocumented Development.

My brief testimony apparently struck a responsive chord, for I had numerous communications from industry and Government personnel indicating support of my idea. Subsequently, the General Accounting Office conducted a thorough review of the proposal—interviewing a number of officials familiar with weapon system development—and reported to Congress that parallel development should be used more frequently in the future.¹ The purpose of this article is to more fully state the basis for my conclusion that parallel undocumented development is a worthwhile alternative strategy to be considered in developing a new weapon system and to explain some of my ideas as to how such a developmental program would operate.

Initially, let me disclaim any claim of novelty in the system of parallel undocumented development. It is generally true that there is “nothing new under the

¹ Comptroller General Report No. B-39995, July 14, 1969.

sun" in Government procurement and this adage certainly applies in the case of parallel undocumented development. Throughout the history of systems development, there are instances of parallel development; and, in the past, development was conducted with a relatively small amount of documentation. Thus, this proposal can be considered a suggestion that we return to older methods of systems procurement in certain instances. If there is any grain of novelty in the proposal, it is in the suggestion that parallel undocumented development be adopted by DOD as a normal procurement strategy in the systems area.

Evolution of the Present System

The largest single category of noncompetitive procurement in DOD is follow-on purchases of weapon systems where the prior sole-source development has locked the contractor into the manufacturing cycle. Many observers of this system have noted its debilitating effect in providing the type of motivation for cost effectiveness that is induced by healthy competition. Yet we have not devised a procurement strategy which successfully deals with this situation. Since parallel undocumented development purports to address this matter directly, it will be useful to sketch the evolution of the present sole-source development technique and the steps that have been taken to live with this technique.

"This procurement method, in GAO's opinion, has merit as an acquisition strategy for advanced weapons systems, subsystems, and other military hard goods which have probable technological or strategic uncertainties or which intend to penetrate state-of-the-art frontiers."—Comptroller General's Report to the Congress, July 14, 1969, Case B-39995

Prior to World War II a great deal of development was done competitively, with numerous contractors being invited to construct prototypes or demonstrate workable hardware. After the war, however, an evolution in development methods occurred. The burst of technological advancement made it possible for the military to call for highly sophisticated hardware, and, of course, this greatly escalated the cost of weapon system development. By the 1950's these comparatively high costs prohibited contractors from undertaking major development efforts with their own funds and impelled the Government to look for a system which would not require duplication of development money. Thus, sole-source development became the normal procurement technique in an effort to reduce the cost of military hardware. This evolutionary change in procurement policy was undoubtedly fostered by the significantly improved management systems that were available by the middle fifties and the growing confidence of the engineering profession in their ability to successfully utilize technology. These two factors led military managers to believe that the Government agencies could satisfactorily monitor and control sole-source development contractors. Since the sole-source development placed the military agency at the mercy of the contractor, the fact that these management and control systems added a significant amount to the cost of development was accepted as a necessary expense.

By the early sixties it had become quite apparent that this was not a cost-effective system. The Harvard Study of the Weapons Acquisition Process pointed out the presence of significant increases in costs and there were a number of relatively spectacular instances of technologically deficient systems. However, DOD management did not conclude that these deficiencies were traceable to sole-source development. Rather, they believed that the difficulties lay in inadequate definition of the project prior to undertaking the development effort and to inadequate monetary incentives to encourage

cost-consciousness by development contractors. The result was a new system of contract definition and greatly increased use of incentive provisions in development contracts. Moreover, more elaborate management systems were developed in an effort to ensure against poor contractor performance. The culmination (and apparently the highwater mark as well) of these efforts was the C-5A procurement, where the Air Force simultaneously required the use of all of its management and data systems in a fully defined development contract with massive financial incentives imposed on the contractor. Although a spectacular example is not necessary to demonstrate the weaknesses of this system, the C-5A situation certainly serves admirably to make the point.

From the above discussion, it is apparent that I believe the present system has not met the needs of DOD. It has not failed because of the lack of ability of the people using the system. In fact, we have never had so many skilled engineers, competent managers, or able procurement personnel working in the field. Neither has it failed because of our lack of sophisticated contracting and management techniques. We can write highly complex contracts and manipulate wonderful management systems. The computer has given us the ability to process data in quantities that would have been unbelievable a decade ago. Rather, I believe the failure is traceable to an overuse of our new sophistication in these areas to the disregard of basic fundamentals. We place a development contractor in a sole-source position where all of the laws of human nature and business impel him to design for high performance and high corporate profits during manufacture of the system, while at the same time imposing upon him massive financial and management constraints in an attempt to induce or coerce him to control his costs and meet his schedules. In theory, we have created a balance, but the practical result is similar to the balance achieved on a delicate scale with 10 tons of weight on each arm. The system assumes that no major technological difficulties or challenges will arise during development and that the minor difficulties and opportunities that do arise can be dealt with using good technological and business management. However, in fact, we know that technological difficulties and opportunities of major significance continue to occur² and that the rigid contractual arrangement is an impediment to sound decision-making during development. The weights on the arms of the scale are so heavy that it doesn't move when weight is added or subtracted from one arm. The present system has created a sort of management paralysis at the very time when the need for good technical management is at a premium.

² AIA Aerospace Technical Council Report, Essential Technical Steps, and Related Uncertainties—DOD Weapon Systems Development, 1968.

Proposed System of Parallel Undocumented Development

The most straightforward way out of this dilemma is to return to the use of more than one development contractor for each major weapon system. Succinctly, parallel development contemplates the award of two development contracts for a weapon system to competing contractors. These contractors would be informed that only one of them would be selected for the production of the weapon system and that this selection would be based on the success of the development effort. Because of the highly competitive nature of such a parallel development program, the Government could safely use cost-plus fixed fee contracts for this stage of the program. This would allow the development contractors significantly more freedom in achieving optimum technical results in the development and would adequately protect the Government since any major overrun could be overcome by canceling the overrunning contractor and continuing with the competitor.

Parallel development will allow development contractors to move quickly into the development effort without the start-stop impediments of contract definition. It should allow them great latitude in exploring alternate technical solutions free of close Government supervision and of early configuration management design baselines. It should also permit the managing military agency to substantially reduce the size of the project office during development. With the prospect of two choices of a weapon system, the military agency should be much more willing to give the contractors this sort of freedom—after all, it will be in the rare position of not having all of its eggs in one basket.

Parallel development will also be of significant benefit in avoiding the need to make the determinative source selection decision on the basis of a "paper competition." For the past two decades, almost all weapon system source selections have been made on the basis of evaluating the promises of competing contractors. It hardly needs to be said that some of the promises made in these circumstances have been extravagant. In addition, there have been some curious instances when a contractor won a paper competition on the basis of a certain set of technical assumptions and later developed a weapon system which incorporated the technical features of one of the losing competitors—witness the supersonic transport or the F-111. There seems to be a growing recognition that the paper competition is a rather ineffective and unfair method of selecting a weapon system contractor. Thus, the fact that parallel development offers a means of avoiding this source selection difficulty would appear to be a strong argument in its favor.

A key question in considering the use of parallel development is the timing of the selection of the win-

ning contractor. Several alternatives are available. The procuring agency would probably determine at the outset that the parallel development program should be conducted to a certain stage in the development effort. For example, in many cases it would be desirable to carry the development contractors through testing of prototypes but there might be instances when sufficient definitive information for choosing manufacturing contractors could be made available at an earlier point in the development process. The criteria for selecting this decision point would be the availability of adequate technical and financial information at the time of the decision so that a conclusive determination of the most cost-effective weapon system could be made and the winning contractor committed to a fixed-price type manufacturing contract. In programs where the agency did not have adequate program visibility to select this point at the outset, a system could be devised giving the Government three or four decision points at which the selection could be made. In this situation, the competing contractors would be asked to submit a manufacturing proposal and technical information at each decision point, with the procuring agency having the option of making a source selection at that point or continuing parallel development to the next decision point. In any case, the winning contractor would be committed to a fixed price type manufacturing contract as an intrinsic part of the selection process.

It might be noted that such a system simulates the commercial market environment much more closely than the present sole-source development contract with incentive provisions. In commercial development, the contractor has full control of future development expenditures, i.e., he can cancel a development program at any time. Thus he has full control of the risk he takes in expending development funds with no significant commitment for future development costs. Yet the contractor has ample motivation to achieve success in his commercial development efforts, since the future of the company is based on the introduction of a certain number of successful new products each year. He is also highly motivated to satisfy the needs of potential buyers since he knows that his competitors are close at his heels (or further advanced). Parallel development would make use of this same motivation to become the manufacturer of the weapon system.

Cost of Parallel Development

Two major objections are generally raised to the parallel development technique. First, it is suggested that such a system is too expensive, and secondly, that it is too slow. Addressing the first of these objections, it should be candidly admitted that parallel development will undoubtedly increase the costs of development of weapon systems. However, it is my firm belief that whatever additional cost is required will be money well spent

and that this issue should be forthrightly aired before the congressional committees responsible for defense appropriations. Spending additional money for development work may well save significantly greater sums in manufacturing and operating costs, and will certainly provide greater insurance against the total failures that have occurred in past years under sole-source development efforts.

An additional factor to be considered in appraising the objection of excessive costs of parallel development is our lack of knowledge of how much additional cost would be incurred. This question brings into consideration the "Undocumented" portion of my proposed technique. Since two contractors would be undertaking the development effort, there seems to be much less need for close surveillance of these contractors by the Government and certainly much less need for the massive configuration management systems presently being used. Rather, it would be my suggestion that the contractors be encouraged to conduct the development effort under austere conditions with the minimum amount of paperwork commensurate with sound engineering practice. There are recent instances of such development programs (the French Mirage fighter, the Convair Charger, and perhaps the Lockheed U-2) which have apparently followed such a development strategy, with the result that development costs were significantly reduced. The amount of cost savings to be achieved by such an attempt to do away with the excessive paperwork requirements at the present time is somewhat speculative—particularly since any significant saving would undoubtedly depend on the willingness of the military managers of weapon system programs to give up a good deal of the visibility and control they currently exercise over development programs. If this problem can be overcome, it would appear that the significant savings which can be achieved by undocumented development will substantially offset the additional costs of parallel development.

Further, in terms of total systems cost, parallel development may not be excessively burdensome. George Schairer of the Boeing Company has estimated that parallel development through the prototype phase adds 6 percent to the total cost of an aircraft program with a contemplated production of 500 planes.³ Since this estimate is based on the assumption that the additional competition will generate no savings in manufacturing costs, it can be considered an outside limit of cost for parallel development. I would argue that parallel development can actually be expected to decrease manufacturing costs by a significant amount—with the result that in programs with large manufacturing quantities, parallel development may not increase total program costs. This, of course, does not mean there will be no budget diffi-

³The Role of Competition in Aeronautics, the Wilbur and Orville Wright Memorial Lecture of the Royal Aeronautical Society, Dec. 5, 1968.

culties since additional development costs cannot be covered out of future production appropriations.

Impact on Development Time

The second objection to parallel development is that it may greatly increase the total time required by the development cycle. It is likely that there is validity to this point if the decision to commence manufacturing is not made until completion of a program of testing prototypes. However, as was suggested earlier, parallel development could be carried to an intermediate stage of development rather than to the end of a test program if the time problem were critical. In addition, parallel development should allow much faster commencement of the development effort, since there would be no need for an elaborate contract definition effort when parallel development was used. Finally, a significant reduction in the documentation requirements would allow a commensurate reduction in development time. With this number of variables affecting the total time of development, it is difficult to determine the impact of parallel development on the time of development. However, it seems apparent that the procurement could be devised in such a way that total development time would not greatly exceed that expected under present-day development techniques. It is my conclusion, therefore, that the objection that parallel development is too slow is not a valid reason for refusing to experiment with this development technique.

An attractive side benefit of parallel development is the technical insurance which is provided by having two contractors simultaneously attempting to solve the problem. However, I would like to emphasize that, from the point of view of a procurement-oriented person, this aspect of parallel development is no more than a side benefit. The logic of my suggestion relates to the use of parallel development as a sound business proposition, providing the proper motivation and environment for both Government and industry. The fact that the Government obtains technical insurance is certainly another reason for experimenting with a parallel development technique. But if this becomes the major reason for using the technique, we will have progressed no further than our present position.

Compared With Contract Definition

Some people have commented that parallel development is merely an extension of contract definition. In a sense this is the case, since one of the basic reasons for parallel development is to extend the competition beyond the end of the contract definition phase. Thus it would seem that any efforts to broaden the scope of contract definition, such as those proposed by General Anderson for use in the Army programs, would be a step in the direction of parallel development. Ultimately, however, I believe that the use of parallel development

would greatly modify the contract definition technique. For example, if it were decided that development efforts should be conducted in parallel for the first 18 months of development, there would be much less need to undertake the detailed work now necessary to prepare the development contract during the contract definition phase. Rather, it seems likely that the development contractors would be allowed to work quite independently for the first 6 to 12 months of the development program, with the requirement that a more precise definition of the project be prepared at the end of the 18-month parallel development effort. In this sense, parallel development allows a return to the greater development flexibility available in the late fifties and early sixties, with the added provision that a very precise statement of future work would be required at the point of selection of the winning contractor. Assuming that the bulk of the development work were done in parallel, this work definition would, of course, comprehend the manufacturing effort to a much larger extent than it would the remaining development effort. Thus, the further parallel development is utilized, the less the end product of parallel development will resemble the end product of contract definition.

Contrast with Total Package Procurement

It is also interesting to compare parallel development with total package procurement, since they are both directed towards solving the same problem. Total package procurement deals with the problem of locked-in development contractors by making the manufacturing effort an integral part of the development contract. This technique creates the proper motivation in that it tends to prevent the development contractor from overemphasizing technical accomplishments to the detriment of manufacturability and maintainability of the weapon system. It also provides significant incentives to control the total cost of weapon system programs. However, total package procurement does create difficulties. First, it requires a series of contract provisions which closely define those risks for which the contractor is not responsible, and, as demonstrated by the C-5A experience, these provisions are difficult, if not impossible, to justify in the political arena. Secondly, it gives a sense of false security to DOD management in believing that a contract ceiling price gives assurance against program cost overruns of great magnitude. As again demonstrated by the C-5A experience, a firm contract price will not protect the Government or the contractor against unanticipated technical difficulties or unforeseen fluctuations in the economy. Parallel development is a better reflection of reality in that it does not attempt to determine total program costs prior to the undertaking of development, but delays this detailed cost estimating until additional information becomes available. In fact, as mentioned above, the primary criteria

for the source selection decision at the end of parallel development should be the availability of reliable data for the balance of the program. Thus, it would seem completely logical that a parallel development effort would be followed by a total-package type contract for the balance of the program; and, in this sense, parallel development serves the purpose of providing better cost information on which to base a total package procurement. In this regard, it should be noted that parallel development followed by a total package-type contract is only relatively better than the present total package procurement system—it gives better protection against unforeseen technical difficulties but does not overcome the problem of economic fluctuations. In summary, parallel development would ameliorate some of the difficulties of total package procurement—perhaps to the extent that total package procurement would evolve into an acceptable system of weapon systems acquisition.

Compared With Multiple Incentive Contracts for Development

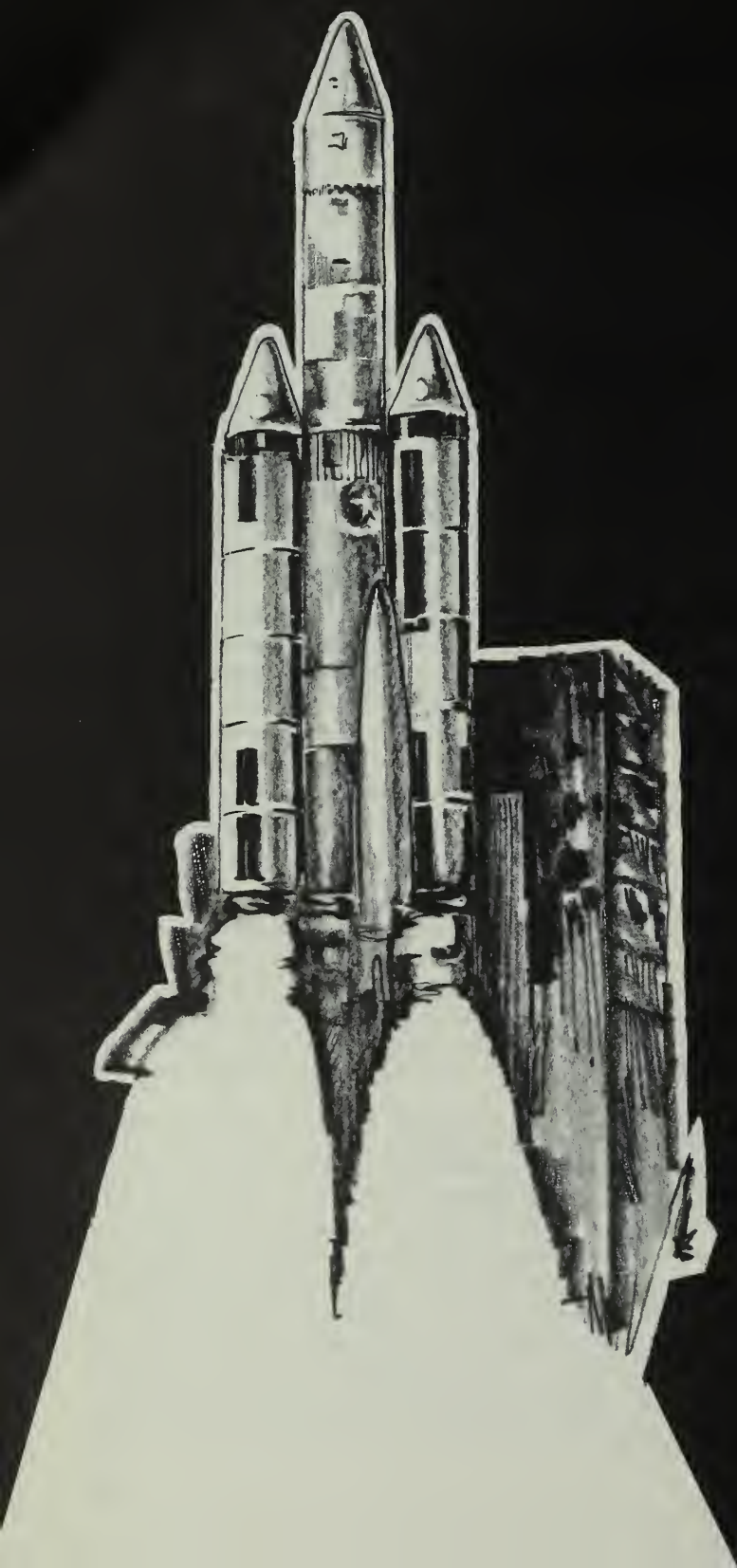
Finally, parallel development should be compared with the present system of using multiple incentive contracts for the development of weapon systems. The multiple incentive contract motivates contractors but it has two significant weaknesses. First, it tends to motivate the contractor to focus his attention on meeting the goals of the development contract rather than the goals of the entire program, since it is almost impossible to incorporate the program goals into the development contract as incentive targets. Thus, multiple incentive contract almost inevitably misdirect the contractors' efforts. (This difficulty is, of course, based on the questionable presumption that the contractor attempts to maximize profits under the multiple incentive contract. To the extent that this is not true, we encounter the logical dilemma of using incentive contracts to

motivate the contractor in a certain way but understanding that we do not expect him to act in accordance with these motivations.) Parallel development overcomes this difficulty by focusing the development contractor's attention on winning the ultimate competition, which is based on program goals, not development goals. The second weakness of the multiple incentive contract is that it presumes an ability to precisely define development targets prior to undertaking the development effort. Parallel development does not make this fallacious assumption—rather, it allows the development contractors to work at the technical problems freed from the constraints of contract targets which may later turn out to be distorted or unrealistic.

Conclusion

In summary, it is my belief that DOD can achieve significant benefits by utilizing parallel development as a weapons acquisition strategy. I do not advocate this technique as the only strategy that should be used, but rather as a promising alternative which should be considered at the inception of each weapon system. It would seem that the use of parallel development would be most beneficial in those cases where large quantities of the system are anticipated and where the system presents significant technical difficulties to be overcome during development. Thus, experimentation with the use of this system might well commence with a few such weapon systems. If the strategy proves beneficial in these cases, it could be expanded for use in other situations. Ultimately, it is my hope that parallel undocumented development will become another accepted procurement strategy giving program managers and procurement personnel an additional degree of flexibility in their efforts to improve the government procurement process. □

I shall try to correct errors when shown to be errors, and I shall adopt new views so fast as they shall appear to be true views.—Abraham Lincoln



HARNESSING
VALUE
ENGINEERING
POWER

By LT. GEN. JOHN W. O'NEILL
*Vice Commander, Air Force Systems Command**

IN WRITING of Science and Industry in the 19th century, Prof. J. D. Bernal of the University of London made this interesting comment:

"The technical break involved in large scale steel production was one too great to be bridged by slow improvements of existing techniques; it needed fresh and imaginative minds that did not know what could not be done."

That perceptive insight echoes something Sir Henry Bessemer wrote in his autobiography. Speaking of his entry into steelmaking, he recalled: "My knowledge of iron metallurgy was at that time very limited * * * but this was in one sense an advantage to me, for I had nothing to unlearn."

Tradition—"Same Old Way"

Those two statements to me embody the very essence of what has come to be called Value Engineering. The entire VE concept, as I see it, is based on a break with the traditional and customary way of doing things. The "way we've always done it" is by no means always necessarily the best way. And, as Department of Defense VE experience has demonstrated, the "old way" is not very often the most economical (or, in other terms, cost/effective) way, either.

* The author commanded the Air Force's Space and Missile Systems Organization at the time the article was written.

The fact that VE can dramatically increase the value of a particular system or subsystem at no increase in its cost—or, more usually, preserve the original functional value at a marked decrease in cost—is a compelling argument for intensified management emphasis on this fruitful source of defense savings.

Certainly it can come as no surprise to anyone that, in today's economic and social environment, the greatest challenge to defense managers consists of wringing the maximum value from every defense dollar expended. The complexity of modern weapons and related systems—to say nothing of the far more sophisticated systems looming over the horizon—presupposes a truly awesome commitment of national resources at a time when competing claims for these finite resources are being pushed with tremendous urgency.

The SPO's Responsibility

The burden of proof therefore weighs more heavily than ever before upon us as systems managers: To produce systems that reliably meet performance requirements, to deliver them on schedule, and to bring them in *at the lowest overall cost*. This requires, more than at any previous time, a concerted team effort as between the System Program Offices, on the one hand, and the contractors on the other. And, obviously, such teamwork is dependent upon contractual arrangements

between Government and industry that are equitable to both. What is basically involved is the establishment of definitive goals—and of *incentives* which provide the necessary thrust to reach those goals.

The purpose of this article, then, is to share with the reader our experience at the Space and Missile Systems Organization (SAMSO) with the use of VE as a vehicle for reducing program costs—and more particularly, with the contractor VE program.

By way of context, SAMSO spends more than \$2 billion a year and the organization's cumulative space and missile investment to date exceeds \$30 billion. That size ballpark obviously contains a great deal of room for cost reduction endeavors.

In fiscal year 1969, our assigned VE cost reduction goal was \$15.8 million. Actual achievement for the year was some \$50 million in command validated Government savings, an all-time high within the parent Air Force Systems Command (AFSC). The \$50 million figure, further, represents command validated savings for the single fiscal year; more realistically, the total estimated program savings for a 3-year period, arising out of the actions taken in fiscal year 1969, will be something on the order of \$95 million.

These savings were produced both by our contractors and by in-house actions of our SAMSO program of-

fices. The point I would make, however, is that—in fiscal year 1969 as in prior years—the greatest proportion of the savings resulted from internal SAMSO actions. Of the \$50 million mentioned above, \$39 million came from 53 in-house Value Engineering projects. Most of these were accomplished in the design, development, and production of our systems.

VE in Systems Definition

It should not be particularly surprising that SAMSO has always done exceedingly well in reducing costs through internal actions. We have, after all, utilized the systems engineering approach in the acquisition of major systems; and systems engineering, like Value Engineering, is predicated upon rigorous *functional* analysis. In effect, this systematic approach to defining total system requirements is actually Value Engineering in action during the system definition phase of the program. Through this process, consistent with time constraints, *value* is defined in measurable terms, and we are thereby provided increased visibility into the costs directly related to the detailed requirements. In this system definition phase, however, it is extremely difficult to validate dollar savings, since there is no base line with which to compare cost improvement.



Engineering and management personnel of Aerojet-General Corporation's Electronics Division in Azusa, Calif., brief the author (center) on thin-film, hybrid micro-miniaturized electronic techniques. SAMSO designs, develops, tests, and procures the Air Force ballistic missile systems, reentry vehicles and satellites.

For this reason, insofar as *auditable* savings are concerned, VE in SAMSO plays its *major* role in the design, development, and production of our systems. Because of time constraints, and because many engineers are hardware-oriented with preconceived design solutions (unlike Bessemer, who had nothing to unlearn), it is in this phase that we uncover the greatest potential for Value Engineering. Our internal efforts in this area over the years would certainly seem to attest to that fact.

But I firmly believe that our contractors have an enormous, as yet barely tapped, potential to utilize VE as a means of reducing program costs *to our mutual economic advantage*. Contractor support of the VE programs prior to fiscal year 1969 was at a somewhat lesser level than we could have wished. In fiscal year 1968, for example, the box score for all approved Value Engineering Change Proposals (VECP's) was only about \$3 million. This represented a serious decline in VECP savings, one so sufficiently alarming that we placed our major emphasis in fiscal year 1969 upon *motivating* our contractors to submit VECP's. The fiscal year 1969 results (\$11 million as the Government share of contractor VECP savings) were greatly encouraging, but I am by no means satisfied that this represents the best that SAMSO and its contractors can do. There is still a long way to go, and the distance is magnified in the current national climate. Even so, that progress dramatized the genuine utility of VE incentive provisions as a contractual mechanism for stimulating really meaningful savings in fiscal year 1969 and beyond.

VECP Track Record

While SAMSO's internal efforts have produced increased savings with each succeeding year, such results, rather than producing complacency, only heighten our awareness of how much better we could do through contractor efforts. Our contractors, after all, together with their subs, can exert tremendous leverage for reducing program costs through proper motivation. And yet, despite pronouncements from the higher levels of DOD, and increased contractor sharing provisions in the Armed Services Procurement Regulation (ASPR), the contractor VECP track record has proved to be less than it might have been. The fiscal year 1968 figure of \$3 million produced by contractors stands in stark contrast to the total \$2 billion procurement package. It was clearly obvious, then, that there were major problems with the contractual VE program.

To correct these problems, SAMSO last year appointed a full-time Staff Value Engineer, and developed a blueprint for action. The two-pronged approach included an investigation into the causes of poor performance, and the development of remedial actions to

motivate our contractors toward greater profit through increased VECP activity.

The first phase, investigation, revealed that the major reasons for low contractor participation in fiscal year 1968 were as follows:

- Inadequate emphasis on VE as a profit making tool by contractor *top management*;
- VECP *goals* either nonexistent, or not allocated to line or program managers;
- Lack of contractor/SPO *team approach* to exploit the fullest potential of VECP's as a means of reducing program costs;
- Disputes over authorship of ideas;
- Contractors discouraged by high VECP rejection rates (54 percent rejected), and lack of detailed explanation for some rejections;
- Sharing ratios considered too low by many contractors;
- Poor quality VECP's;
- Contractor and SPO motivational and recognition programs either nonexistent or inadequate.
- Procedures for recording idea authorship, and for preparing VECP's with a high probability for success, inadequate;
- Complaint by some contractors that VECP's were occasionally converted into Engineering Change Proposals (ECP's).

Attacking the Problems

In order to correct some of these problems within our organization, we developed a positive plan of action for the fiscal year 1969 program. First, we saw to it that all contracts would be processed through the Staff Value Engineer for approval, to insure an adequate sharing arrangement for real motivation. Next, a VECP submission goal—with a 70 percent approval rate—was assigned to each program office. At the same time, we established procedures for tracking every VECP through the system to insure rapid processing.

To convince our contractors that we meant business, I wrote to each major contractor. The substance of the letters was to assure them of my commitment to the VE program, and to solicit their support so that we could collectively benefit from the great potential of VE. Their responses were most encouraging, but short-term enthusiasm rarely pays off; to insure a really dynamic program, VE must be an *integral* part of total program management.

So, as a followup to my letters the SPO's initiated a contractor visitation plan; the specific purposes of the visits were: (1) to convince the contractors that the SPO's were, in fact, responsive to VECP's; (2) to discuss and resolve mutual problems; and (3) to establish lines of communication for processing VECP's.

Despite the tight situation with regard to travel funds, all major contractors were visited; these meetings were, in my opinion, the *key* to the breakthrough in the con-

tractual VE program. For the first time in SAMSO, we established formal procedures for previewing VECP's in order to eliminate unnecessary expenditure of contractor funds on VECP development, and to insure a better chance for approval. These procedures further assured both the contractor and the SPO that only those VECP's with a high probability for success would be formally submitted.

This proved to be an eminently workable approach; a SPO/contractor team spirit was developed, and the contractors now felt they could commit funds for developing VECP's with a fairly high assurance of success.

The results, I think, speak clearly for themselves. Whereas in fiscal year 1968, 55 percent of the VECP's submitted were approved, for a savings of \$3 million, fiscal year 1969 figures showed a 63 percent approval rate with a total Government savings of approximately \$11 million.

That certainly represents a trend in the desired direction, but I strongly believe that we have still barely scratched the surface in exploiting the potential of the contractual Value Engineering program. Yet we have surely demonstrated that the thrust required to go a great deal farther along this road can only be supplied by *top management* concentration on the program—and by a *team approach* as between the Government and the contractors.

Looking Ahead

During fiscal year 1969, SAMSO marshalled all the resources at its command to meet the Value Engineering challenge, and to wring the maximum potential out of the contractor end of the program. From this experience and the results produced, it has become clearer than ever that workable *incentives* for the contractors are essential to the achievement of Air Force saving goals. The time has clearly come, I believe, for all to recognize that our entire American economic system is based upon profit; that profit is the sole fuel and lubricant upon which American industry is run; and that by enhancing profit possibilities we can best be assured of getting the best systems, on time, *and with the greatest degree of economy*.

Everyone in the AFSC Space and Missile Systems Organization is justifiably proud of the improvement in SAMSO contractor VECP performance last year,

and of the way in which problems were transformed into opportunities. As SAMSO commander during that time, I naturally share in that pride. But none of us feels that we have a soft bed of laurels to rest upon. The people of SAMSO are pledged to the vigorous pursuit of Value Engineering across the board, in software as well as hardware, and in every program under their jurisdiction.

We have made a beginning. Continued progress will depend upon fresh and imaginative minds, minds which, in Professor Bernal's words, do not know what cannot be done. From my years with them, I know that those are the kind of people we have in SAMSO. □

Number of HI-Dollar Value VECP's Approved in Fiscal Year 1969 by DOD Program*

Program	Number approvals	Service
F-111 Aircraft.....	14	AF
Tow Missile System.....	9	Army
Machine Gun, GAU 2B/A ..	9	Army
Phoenix Missile System....	8	Navy
AGM 65-A.....	6	AF
UH-1 Helicopter.....	6	Army
Titan III.....	5	AF
MINUTEMAN III Missile System.	5	AF
TC106 Jet Engine.....	5	AF
Chapparral Missile System..	4	AF
M-561 Vehicle.....	4	Army
FM 54-B Fuze.....	4	Army
Telephone System 1548A...	4	Army

*List includes only those programs in which 4 or more VECP's were approved in fiscal year 1969.

Source: Value Engineering Directorate, Office of The Assistant Secretary of Defense for Installations and Logistics.

MAC'S ISOCHRONAL CONCEPT

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A MAINTENANCE MANAGEMENT TOOL

By **RUSSELL L. BUSH**

Colonel, USAF

*Assistant Deputy Chief of Staff, Materiel
Headquarters, Military Airlift Command*

"The concept makes for a positive approach to 'scheduled' maintenance, eliminating the peak-and-valley maintenance workloads created by fluctuating flying hour generations."

Need to Reduce Groundtime

Strategic military airlift, for long-range combat mobility and rapid worldwide logistics, can be only as capable as the aggregate *productivity* of its transport aircraft. Technically, the airlift productivity of a single airplane is, within fairly narrow limits, inherent in its design; it is a product of speed and capacity, measured in ton-miles per hour.¹

But the actual and meaningful productivity of the entire Military Airlift Command (MAC) airlift force is contingent upon the *total* number of ton-miles it can produce every day, every month, every year. Thus, the governing variable is the number of hours each aircraft—and *all* aircraft—can be kept in the air every day, day after day, year in and year out. An airplane on the ground, to put it in simplest terms, is losing money.

The necessity for maximum aircraft utilization, over both the short and long term, has always been a fact of life for MAC, and the Military Air Transport Service and Air Transport Command before it. Hence, one of the dominant pursuits of the Command throughout

¹For those unfamiliar with the term, a "ton-mile" is the movement of 1 ton over a distance of 1 mile. In the Air Force, the nautical mile (6,080 feet) is the unit of distance employed.

its history has been a continuous *search* for ways and means of reducing groundtime. This search has produced various systems of crew scheduling and staging; loading and unloading procedures; material handling methods and equipment; mechanization and automation of warehouse activities; and numerous others.

But the major cause of aircraft being designated as "not operationally ready" is inevitably found in the area of maintenance. Obviously, then, the reduction of maintenance groundtime is the most fruitful area for exploitation in bringing airlift force productivity to its maximum limits. MAC has therefore concentrated heavily on this aspect of its operation, not only at the home bases of our aircraft, but also at the enroute and turnaround stations.

One very successful result of this concentrated effort is the Isochronal Inspection system. "Isochronal" means, simply, "equal intervals of time." The entire concept is based on the obvious fact that it is a great deal easier to predict when the 25th of April (to pick a date out of the air) will arrive than it is to forecast with any certainty when a particular airplane will have flown a given number of hours.

Inspection Scheduling System Outmoded

I say "obvious," but the fact is that the latter way of operating—basing organizational aircraft inspections upon the accrual of flying hours—has always been more or less the accepted system throughout the Air Force, and in MAC and its predecessor organizations. Actually, the system was eminently logical in an era of reciprocating engines and propellers, which deteriorated as almost a linear function of flying time. Furthermore, high airframe utilization was not a daily necessity in nonairlift operations, so that the ups and downs of the periodic (based on flying hours) inspection systems did not have quite the adverse impact upon other commands as they did on MAC.

It was, therefore, the unique utilization requirements of MAC operations, coupled with the acquisition of our early jet (C-135) aircraft, that led to the necessity for something better in the way of inspection practices. So we adopted a "phased inspection" concept. This system evenly split the organizational inspection into equal work packages, and thereby improved scheduling and reduced groundtime for a given inspection. But the phase inspection was still based in essence on the accrual of flying time; for that reason, it fell short of providing the kind of airframe availability and force flexibility our combat and logistical airlift mission demanded.

Isochronal Concept Born

With the advent, in mid-1965, of greatly expanded operations to Southeast Asia, the arrival of the C-141

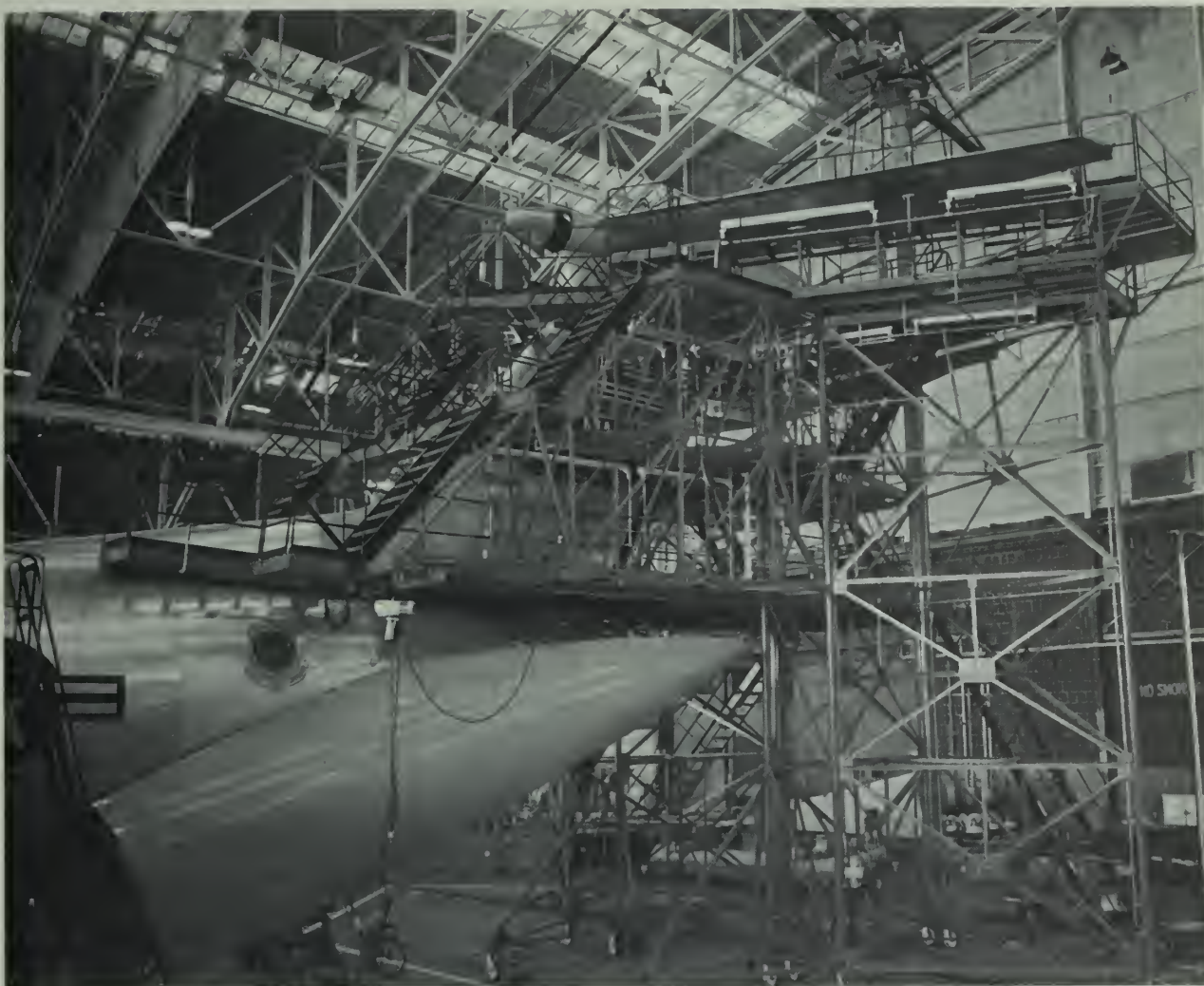
Starlifters, and the "Combat Pacer" directive to increase daily aircraft utilization by some 60 percent, a still better maintenance concept became mandatory if we were to meet our enormous operational requirements.

That was the genesis of the Isochronal concept, but, for added perspective, it is necessary to understand that MAC, like no other operational command, works on a mission, rather than a sortie, basis. A *mission* proceeds from an on-load base (which may be either an established aerial port or a special pickup point, as, for example, the home base of any Army division) to an off-load base, which may be another port of special location. Each mission usually encompasses from 30 to 70 flying hours and anywhere from six to 10 landings.

Now at any point in this mission, whether intermediate or terminal, the aircraft may be downloaded and diverted to another mission of higher priority. Or at termination, it may be rerouted to perform shuttle operations or participate in intratheater airlift, as often happens in the vast and active Pacific area. To be capable of this sort of versatility and flexibility, the aircraft must belong for all practical purposes to the operator; scheduling is out of the hands of the chief of maintenance at the airplane's home station.

Under the previous modes of managing maintenance (periodic and phased inspections) these operational requirements meant that, before it could be selected for launch, an aircraft had to have sufficient hours remaining before inspection to allow for that sort of diversion and rerouting. Too often, this constraint resulted in unacceptably large numbers of aircraft being unavailable for mission launch. The obvious result was forced inspections to meet mission requirements—and all the inefficiency inherent in that way of doing business.

As long as we were tied to flying times, then, significant peaks and valleys in maintenance workloads resulted, and required operational flexibility was difficult to achieve. Available manpower could not be applied to existing workloads, and total aircraft down time grew excessive. As a single illustration of the general situation, during a 90-day period at one base, aircraft were queued up to the point that the inspection dock was incapable of keeping up, even with the expenditure of inordinate amounts of overtime. At other times during those same 90 days, there were no inspections at all, and the labor potential was lost. Obviously, operational effectiveness was being compromised, and the morale and efficiency of the work force suffered. With comparable situations at other bases, these factors inevitably added up to a loss of quality in the inspections; this of course, further compounded both the operational and maintenance problems.



Functional workstands were developed to permit maximum manloading of the dock and easy access to all areas of the aircraft to be inspected.

Calendar Scheduling More Responsive

It was to alleviate all these shortcomings that the Isochronal Maintenance concept was developed early in 1966 for application to MAC's C-141 aircraft. It was centered around a minor and major inspection, the intervals between depending upon the expiration of a specified number of *calendar days*. These intervals were arrived at by taking into consideration the expected time between overhaul or maintenance actions that are inherently built into systems or components. Flexibility in flying hours then must remain within the best concepts of flying safety and must never be allowed to degenerate to the fly-to-break concept. The flying hours that can be generated within the Isochronal time periods, accruing at an 8-hour-per-day utilization, are well within these optimum removal or maintenance actions times.

At the outset, the intervals were 35 and 70 days, respectively. After 18 months under the new system, however, maintainability experience with the aircraft made it possible to extend the intervals to 45 and 90 days. These are the intervals in use today.

The calendar-day interval, with its inherent predictability, is oriented to the optimum achievable correlation of flying hours attainable, resources available, and meantime-to-maintenance factors. In contrast with the old system, under which the operator was rigidly constrained by "flying hours remaining to inspection," the only contract the operations people now have to meet is to have the airplane back at its home station on the scheduled maintenance capability throughout the worldwide system. Operations has the airframes realistically dedicated to its requirements, with only a specified date—as mentioned above—as its contractual responsibility.

The Isochronal concept also provides for the total application of the Reserve Associate program; it provides the capability, within engineering design limitations, of accelerating immediately to wartime utilization rates, and to effectively employ all personnel that could be called to active duty under the program.

The concept makes for a positive approach to "scheduled" maintenance, eliminating the peak-and-valley maintenance workloads created by fluctuating flying hour generations.

That positive approach engenders one of the most important benefits of the system: Precise scheduling insures maximum utilization of our work force during normal duty hours, and within a normal workweek, when everyone is at peak efficiency. We are now able to inspect under optimal environmental conditions—daylight—with all ancillary agencies (Base Supply, POL, shops, motor pool, system support managers, and contractors) at their best posture to render the necessary support.

We can man-load our docks to get maximum effectiveness from every worker. And because the dock workload is stable, we can train the unskilled airman to do a repetitive task and do it well, thereby improving the quality of the inspection. This training of our young airmen in specialized tasks has softened the impact of the shortage of NCO's and skilled technicians.

We are also able to forecast our spares requirements with much greater accuracy as a result of this precision in scheduling. This ability, in turn, establishes a predictable flow of reparable components. Thus, both NORM and NORS (nonoperational readiness resulting from maintenance and supply factors, respectively) rates have been effectively reduced.

And finally, although morale factors are not easily susceptible to direct measurement, the improved attitude of the workers is clearly evident. They know exactly what they have to do and when they will be doing it; they can look forward to predictable offtime; they see that their supervision and environment are the best possible; and they can depend upon adequate shop and supply support. These things just naturally translate into better quality of inspections.

Only Part of Total System

In order to pinpoint what the Isochronal concept is and what it has accomplished, I have treated organizational maintenance up to this point as if it existed in a vacuum. However, it is also necessary to keep in mind that four other basic maintenance functions also contribute to aircraft downtime:

- TCTO Update/Modification
- IRAN
- Home Station/En Route Turnaround
- Unscheduled Maintenance

While the organizational inspection is the activity that happens most often during the life cycle of the airframe, all five functions are interrelated, and each depends upon the others for total success of the maintenance program.

Perhaps the best way to describe the way in which some of these interlocking relationships were affected by the Isochronal concept is to trace the story of the introduction of the C-141 into the inventory.

The C-141 was brought in under a new concept that called for operational use while testing was still in progress. Because of this concurrency, great numbers of aircraft entered the operational inventory with major testing yet to be accomplished. The expected result was the necessity for numerous engineering changes to the aircraft as hardware problems were identified throughout the test program. These hardware changes, in turn, required a large volume of man-hours for updating the aircraft previously delivered.

This man-hour backlog was more than offset by the great increase in airlift capability (at a time when demands were soaring) we achieved at a much earlier time than would have been possible under the old "test first" philosophy. But it was a backlog to be met nonetheless, and in fiscal year 1968 it amounted to 1.6 million man-hours of TCTO/Update modifications.

The important point, however, is this: MAC itself, by reapplying resources that became available as a result of the Isochronal system, accomplished 371,000 man-hours of that total. And during the same time, we were also able to perform an average of 1,200 maintenance man-hours per aircraft of previously scheduled IRAN workload. These are very sizable achievements, but they were *not* accomplished at the expense of quality maintenance; during the period, we maintained a mechanical reliability rate of 95.4 percent worldwide, and up to 74 percent of the UE force was committed to fly on a daily basis. Withal, an unprecedented 8-hour-per-day utilization rate was maintained, and in February 1968 (in response to the Tet and Pueblo crises) the C-141 force flew 9 hours a day without impact on the scheduled maintenance program.

That furnishes a rather dramatic commentary on the versatility deriving from the Isochronal concept. Had the force been committed to an hourly inspection procedure, MAC could not have met the programed requirements, and the docks would have been inundated with aircraft awaiting inspection.

Effect on IRAN

Growing directly out of improved Isochronal scheduling was the recently implemented Incremental IRAN. In coordination with the Air Force Logistics Command (AFLC), MAC converted the C-141 from a 2-year IRAN cycle—requiring approximately 14,000 depot man-hours and 29 days of downtime every 2 years—to a 3-year Incremental IRAN. This consists of three

annual increments, the first two being performed in-house by MAC in conjunction with a major Isochronal inspection, with a flowtime of 7 to 10 days.

Based on current and projected flying hour rates, the flying hour life design of the C-141, and the planned flowtimes for the IRAN increments, we should save 110 downtime days over the life cycle of one aircraft. Or about 30,500 days for the entire C-141 force.

Basically, the capability for scheduling inspections with precision and man-loading the docks effectively made it possible to incorporate certain requirements, previously encompassed within IRAN, into the Isochronal inspections—without extending the downtime for either the major or minor inspection.

Results in Savings

This capability, coupled with the reduced inspection time, has further enabled us to consolidate C-141 facility, tooling, and equipment requirements. As a result, C-141 identified facilities have been reprogramed for the C-5 aircraft, and two docks have been dropped from the C-5 facilities plan—for an overall cost avoidance of 3.5 million dollars.

And there you have the C-141 story, as shaped by the concept and practice of Isochronal Maintenance. It is certainly salutary enough in itself; but it goes beyond that, because our tremendously encouraging experience with the C-141 has pointed the way to the application of the concept to our other aircraft.

Adaptability to Other Aircraft

So, although it was primarily the reliability of the jet that made Isochronal procedures feasible in the first place, we have found that they can bring measurable benefits with any aircraft. Some 10 months of service testing with the C-124, for example, demonstrated a great deal of improvement in the maintenance of that piston-driven airplane, with more airframes made available for missions and bunching of inspections smoothed out. The Isochronal concept, therefore, was put into effect for both active force and Air Reserve Force C-124's in December 1968. Intervals of 45 and 90 days have been established for the active MAC C-124's; the intervals for Air Force Reserve and Air National Guard aircraft vary depending upon utilization rates.

Actually these intervals are based on both aircraft utilization rates and specific inspection problems of a particular aircraft. Since C-124's in MAC are utilized

at a lower rate than the jet C-141's, they will average fewer flying hours between inspections than the jets, even though the calendar intervals are the same. In this way, the limitations imposed by reciprocating engines, propellers, gearing, etc., are allowed for. By the same token, Reserve Forces C-124's are utilized at a lower rate than those on active serve, and this too must be taken into account in establishing the Isochronal intervals.

The MAC Air Weather Service flies both jet and turboprop aircraft; they have been under Isochronal service test since October 1967, and were approved for full implementation by the Commander of MAC in March 1969.

Similarly, the MAC Aerospace Rescue and Recovery Service begins an Isochronal service test with its turboprop C-130 aircraft in May 1969.

And finally, the C-9 jets of the MAC Domestic Aero-medical Evacuation Service are maintained under the Isochronal system.

On the basis of all experience to date, we have recommended to Headquarters USAF that the Isochronal concept is the *only* logical system of organizational maintenance for the upcoming C-5 Galaxy. Since the C-5 will outproduce the C-141 by a factor of four- or five-to-one, and be 16 to 20 times more productive than the C-124, it is crystal clear that the effect of any avoidable downtime with this airlift giant would be tremendously magnified.

In summary, the management actions detailed in this article have made it possible to utilize the C-141 at the intensive rate of 8 hours a day since its introduction into MAC, with peaks above that. The Isochronal concept in action has conclusively proved that fluctuating or very high utilization rates (which are always typical in MAC) make no inordinate demands on the inspection system and, consequently, have no degrading impact upon safety. These management improvements have provided the optimum in flexibility, enabling us to meet tremendous airlift demands to and from Southeast Asia, Korea, and Europe. At the same time, we have been able to compensate, to some extent, for the shortage of skilled supervisors and technicians currently plaguing most major operational commands. And finally, in the very face of sharply rising airlift requirements, these programs have resulted in cost reductions of \$11.5 million to date, with additional savings to be determined.

All in all, we in MAC feel that we have gotten some fantastic results from the seemingly simple substitution of *elapsed calendar days* for *accrued flying hours*. □



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

September 5, 1969.

Hon. BARRY J. SHILLITO
Assistant Secretary of Defense
(Installations and Logistics)
Room 3E808, The Pentagon
Washington, D.C. 20301

DEAR MR. SHILLITO:

The success of the Apollo Program in placing men on the moon is an impressive step in our Nation's space activities. It is one of the many in which we can be justly proud. Our achievements are the result of the cooperative efforts of many thousands of people in industry and government.

The Department of Defense quality assurance efforts performed at our contractors' plants and at certain of our test and launch facilities played a key role in the accomplishment of the first manned lunar landing. The DOD quality assurance support was rendered in a highly competent and professional manner and your personnel have earned a place as an essential member of the Apollo team.

On behalf of Dr. Condon, myself, and all of the people of NASA, please extend to the many contributing DOD organizations our congratulations and sincere appreciation. We look forward to a continuation of our productive working relationship.

Sincerely,

GEORGE J. VECCHIETTI
Acting Assistant Administrator
for Industry Affairs.

QUALITY ASSURANCE

NASA-DOD COOPERATIVE EFFORT

THE SUPERLATIVES have been exhausted in describing the success of Apollo 11—man's first landing on the moon. Apollo 11 is a tribute to and a source of pride for the hundreds of thousands of people who individually contributed to the success of this great achievement. I think that the entire Quality Assurance profession is especially proud of this achievement since they are keenly aware of the extensive attention to detail that is necessary for such a system, composed of some 15 million parts, to perform its mission successfully. In particular, over 1,000 Department of Defense (DOD) Quality Assurance personnel contributed directly to the success of Apollo 11 and the previous manned and unmanned programs which served as stepping stones to the accomplishment of the lunar landing. These DOD personnel, working primarily at National Aeronautics and Space Administration (NASA) contractor plants, are vital members of the NASA Reliability and Quality Assurance team. The evolution of this joint NASA-DOD effort for assuring the quality of space hardware illustrates the benefits to be derived from interagency cooperation.

QA Epitomizes Cooperation

NASA was established in 1958 via Public Law 85-568. The Congress was explicit in expressing its

desire for NASA to work closely with other Government agencies by stating that:

"The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:

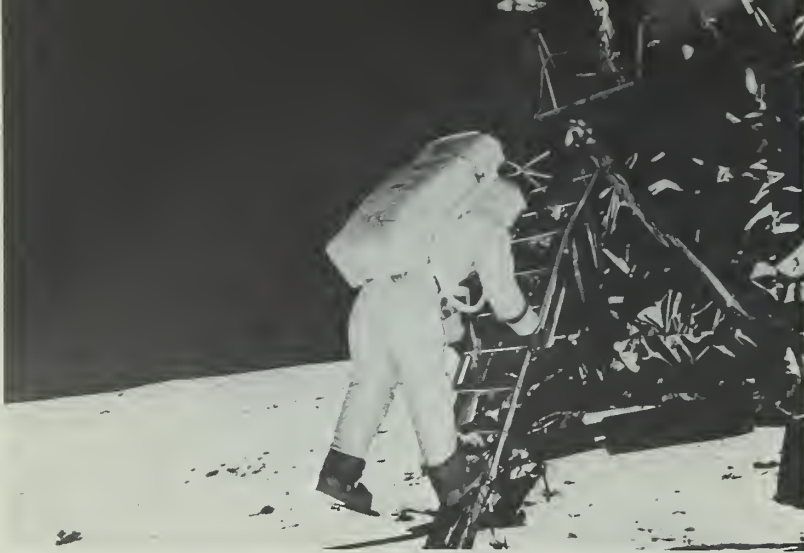
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'The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment.'"¹

One of the prominent manifestations of cooperative effort in aeronautical and space activities is in the field of quality assurance. During the past decade, NASA and DOD have jointly developed the policy,

¹ Public Law 85-568, sec. 102(c) (8).

By DR. JOHN E. CONDON
*Director, Reliability and Quality Assurance
National Aeronautics and Space
Administration*



Astronaut Edwin E. Aldrin Jr. lunar module pilot, descends steps of Lunar Module ladder as he prepares to walk on the Moon. He had just egressed the LM. This picture was taken by Astronaut Neil A. Armstrong, commander, with a 70-mm. lunar surface camera during the Apollo 11 extravehicular activity.

managerial systems and technical competence necessary for the performance of Government quality assurance functions at NASA contractors' plants by DOD personnel. This was not accomplished without significant effort on the part of both NASA and DOD and its continued success will always require special attention.

The basic objective of the Government quality assurance function performed at contractors' plants is to ensure that articles and services conform to contract requirements. It is the policy of both the NASA and the DOD that contractors are responsible for compliance with all provisions of the contract and for furnishing specified articles and services which meet all contract requirements. Government quality assurance activities at contractors' plants are, therefore, aimed at providing the Government buying agency with the necessary "confidence" that the contractor is, in fact, furnishing hardware which meets the technical requirements of the contract. The nature and scope of Government actions is dependent upon the complexity and criticality of the hardware being procured, the extent of contractor responsibility in areas such as design, development, test, and so forth, and previous quality history and experience.

Attention to Detail

The aeronautical and space systems and supporting equipment procured via NASA contracts generally involve small quantity, highly complex, developmental hardware which must perform operational missions without the benefit of extensive flight test experience. Further, the manned flight program, with its compelling human involvement, adds a special dimension of criticality to the importance of the quality assurance function. It is thus understandable that the NASA quality assurance requirements for contractors and the DOD agencies at contractors' plants are both extensive and exacting. *Meticulous attention to detail* is not merely an idle NASA cliché—it is our way of life.



Final systems checkout for the National Aeronautics and Space Administration's Lunar Module (LM-6) were conducted in the Open Bay Area of the Manned Spacecraft Operations Building (MSOB).

NASA's initial policy directive on quality assurance, issued in October 1961, stated that NASA Installations (i.e. field Centers) *shall retain overall responsibility for the quality of procured items and cannot delegate such*. This has been the cornerstone for the formulation and implementation of quality assurance policy and procedures between the NASA and the DOD over the years. In essence, this means that the DOD agencies at the plant-level perform quality assurance functions and tasks specifically delegated by NASA while the overall responsibility for the quality assurance function is retained by the procuring NASA installation. The DOD agency at the plant is, of course, responsible for the effective execution of the functions and tasks delegated to it.

The QA System

As NASA's contractual programs began to increase in 1961, the need to formalize a system for the delegation of quality assurance functions and tasks to the DOD was recognized by NASA. In April 1962, NASA issued a document entitled "Quality Assurance Provisions for Inspection Agencies" (NPC 200-1) and provided for its implementation in the NASA procurement regulations. This established the basic framework within which the cooperative NASA-DOD effort for the performance of NASA quality assurance functions at contractors' plants has operated ever since. The key policy and managerial elements of this system are:

1. The procuring NASA installation retains overall responsibility for the quality assurance function.
2. The specific Government quality assurance functions and tasks to be performed at contractors' plants relative to NASA contracts are identified and delegated to the cognizant DOD plant representative's office via a letter of delegation from the NASA contracting officer. This letter of delegation contains: (a) citation of NASA Quality Publication NPC 200-1 and the extent to which it is applicable, (b) special instructions, as necessary, regarding compliance with the individual provisions of NPC 200-1 and unique or special aspects of the hardware, (c) quality assurance tasks and inspections which are in addition to those invoked in NPC 200-1, and (d) the name and address of the NASA quality assurance representative to serve as the point of contact on matters pertaining to the delegation.
3. The cognizant DOD agency at the contractor's plant responds with a formal acceptance of the delegation and subsequently prepares and submits to NASA a plan for performing the delegated functions and tasks. This plan is reviewed by the procuring NASA Installation thereby ensuring visibility into the planned execution of the delegated functions and tasks.
4. During the life of the contract, the DOD agency at the plant submits periodic quality status reports to NASA and changes to the quality assurance plan as they occur. As necessary for management visibility, NASA quality assurance personnel visit the plant to review and assess the implementation of the delegation and to provide technical assistance.
5. Maximum use of established DOD quality assurance procedures in the execution of delegated functions and tasks when such satisfy NASA requirements.
6. Reimbursement to the DOD, at an agreed to hourly rate, for the performance of all delegated contract administration functions including quality assurance. This policy of reim-

bursement has had two beneficial effects: (a) it has served as a check-and-balance to insure that the NASA quality assurance delegation is realistic relative to the criticality of the hardware and (b) it has helped insure responsiveness from the DOD agencies since NASA is a "paying customer."

Delegation and Execution

At this point it is appropriate to discuss the fundamental features of two major aspects of the system; namely, the quality assurance delegation by NASA and the plan of execution by the DOD agency in response to the delegation. Both of these are aimed at minimizing problems of misunderstanding and communication between the parties concerned. NASA, for its part, must conscientiously determine those Government quality assurance tasks to be performed at the contractor's plant and clearly describe these in the letter of delegation. Further, NASA may choose to retain certain functions (e.g. material review board authority, end-item test, inspection and acceptance of major systems), when such functions are deemed critical to the overall project. Thus the formal quality assurance delegation concept serves not only as a means of communicating the specific tasks and functions to be performed by the executing agency but also serves as a means of insuring that all necessary tasks and functions have been considered and identified. The quality assurance plan developed by the DOD agency at the plant must be responsive to the tasks and functions delegated by NASA. This requires the DOD agency to review the contract requirements and the contractor's quality assurance plan as well as the necessary Government quality assurance tasks and functions. When submitted to the NASA installation the agency quality assurance plan affords NASA the opportunity to review and assess the planned implementation of the delegated tasks, make any adjustments or changes which may be desired, and clarify any misunderstandings. The agency quality assurance plan then becomes the "basic agreement" for the execution of the tasks delegated and is used as a basis for assessing progress and periodic status reporting.

Demands of the Sixties

NASA's contractual programs and activities increased at a rapid pace in the early to mid-1960's placing significant demands on the quality assurance function. This, coupled with the establishment of the Defense Contract Administration Services (DCAS) of the DOD, presented NASA with a formidable challenge relative to the effective management and performance of Government quality assurance functions at contractors' plants. While the basic system, established in 1961-62, was sound, the continually increasing NASA workload placed stringent demands on our experienced quality assurance personnel, required the hiring and training of new personnel and focused attention on facets of

the system which required change and improvement. Also, the establishment of DCAS via Project 60 resulted in the transfer of many of our quality assurance delegations (previously under the cognizance of Army, Navy, or Air Force) to DCAS and presented us with a "new" recipient for our delegations. Thus in 1963, we identified four major areas which were in need of attention and action.

1. A mechanism for discussing and coordinating quality assurance policy, procedures and problem issues between the NASA and the DOD.

2. Improvement and clarification of NASA's requirements for the performance of Government plant-level quality assurance functions.

3. Direction and guidance to NASA Installations for uniform and consistent management of delegated quality assurance functions.

4. Improvement of DOD quality assurance personnel's understanding of NASA's plant-level quality assurance requirements and, thereby, the enhancement of their effectiveness in carrying out such requirements.

NASA/DOD Committee

In late 1963, the NASA/DOD Reliability and Quality Assurance Committee was established by Assistant Secretary of Defense (Installations and Logistics) Thomas D. Morris and NASA Deputy Associate Administrator for Industry Affairs Earl D. Hilburn. The charter stated:

The purpose of the NASA/DOD Reliability and Quality Assurance Committee is to define and coordinate requirements in the area of reliability and quality assurance common to both NASA and DOD and to recommend actions to assure effective use of available resources in satisfying these requirements. This committee will also serve as a forum for the discussion of policy and procedural problems pertaining to the quality assurance services performed for NASA by DOD inspection agencies under field service agreements established between NASA and DOD activities.

The committee was cochaired by Mr. John J. Riordan, Director of Quality and Reliability Assurance and myself as NASA's Director of Reliability and Quality Assurance. This committee served as an invaluable forum for the discussion of managerial, technical, and administrative issues as the two agencies sought to coordinate their efforts in assuring that hardware procured for the space program met necessary quality and reliability requirements. The committee also served as a means of demonstrating to personnel of both agencies that "the other fellow puts his pants on one leg at a time, too." In 1968 it became obvious that the primary objectives of the committee had been satisfied and it was terminated by mutual agreement. Close liaison is maintained today on a continuing basis without the need for a formal committee.

Requirements at Plant-Level

In late 1963, NASA initiated a revision of its requirements for the performance of Government plant-level

quality assurance functions. Since these requirements are executed for us by DOD agencies, it was extremely important that we have knowledgeable DOD quality assurance personnel participate with us in the revision effort. Mr. J. W. Conklin, Air Force Contract Management Division, AFSC; and Mr. Glenn Soares, Office of Naval Material (now Deputy Executive Director, Quality Assurance, DCAS); were members of the revision task group and contributed significantly to the clarity and comprehensiveness of the revision. The revision, NPC 200-1A, "Quality Assurance Provisions for Government Agencies" was issued in June 1964 and was immediately implemented in delegations to DOD agencies.

In August 1965, NASA revised its procurement regulations for the delegation of contract administration and related field service functions to DOD. A significant aspect was the delineation of those plant-level contract administration functions which were *required* to be delegated by the NASA installation to the DOD agency cognizant at the plant and the identification of those functions deemed critical to the project which would not normally be delegated. In April 1966, specific and detailed guidance was issued to implement the quality assurance aspects of these revised contract administration delegation procedures through NHB 5330.7, "Management of Government Quality Assurance Functions for Supplier Operations." This was directed to our NASA installations to insure maximum uniformity and effectiveness in the management of quality assurance functions performed at the plant level by NASA or DOD personnel.

Training

In less than 3 years (1964-66) we improved and clarified the basic quality assurance requirements used in our delegations to the DOD, revised and strengthened our general contract administration delegation procedures and implemented procedures for uniform and effective management by our NASA installation of delegated quality assurance functions. There remained one significant area in need of attention; namely, the institution of an extensive training program for DOD personnel to insure a full understanding of NASA quality assurance requirements.

The Quality and Reliability Assurance Laboratory, Marshall Space Flight Center had been conducting an 80-hour course in NASA quality assurance requirements since 1963. However, as NASA's delegations to the DOD continued to increase in the midsixties it became necessary to find a more rapid and economical means of training large numbers of personnel. In early 1966, at NASA's request, DCAS surveyed its needs for such training and identified approximately 1,200 personnel as having an "immediate" need for NASA quality assurance training. Subsequently, NASA pro-

posed and DCAS agreed to the following plan to satisfy this need:

1. NASA would train a cadre of DCAS instructors in NASA quality assurance requirements. These instructors would then train the 1,200 personnel identified in the survey.
2. NASA would authorize direct reimbursement of training costs—salary, travel, and per diem—for the 1,200 personnel.
3. DCAS would continue the training program, upon completion of the 1,200, at no direct cost to NASA.

A six-man joint task group, under the chairmanship of Mr. Daniel Negola, NASA, was established to carry out the plan. During the summer of 1966 the task group accomplished the following:

1. Developed a concentrated 40-hour training course in NASA quality assurance requirements including a comparison of applicable DCAS procedures and practices as contained in the DCAS Quality Assurance manual. The material developed included instructional guidelines, quizzes, a final examination, and a coordinated textbook manual.
2. Developed prerequisite criteria to assure a minimum level of knowledge of all training candidates.
3. Trained and qualified, through trial training sessions, a cadre of DCAS instructors.
4. Established instructor teams for the Western, Central, and Eastern areas of the country and initiated the training program which featured "taking the course to the students."
5. Invited the Air Force and Navy to send plant quality assurance personnel performing delegated NASA quality assurance functions to courses offered in their geographic area.

The formal training program began in Los Angeles in September 1966 and was completed in June 1967. A total of 1,119 quality assurance personnel were trained during the 10-month period; this included 74 from Air Force and 10 from Navy.

Through the excellent cooperation of DCAS, NASA realized tangible saving in both cost and time. Compared to satisfying this training need through the previously offered course at NASA's Marshall Space Flight Center, this cooperative effort resulted in measurable savings for NASA of \$860,000 and 2–3 years of time. Of course, the principal result was better understanding by DOD quality assurance personnel of NASA's quality assurance philosophy, policy, terminology, and detailed requirements and the application thereof. This, in turn, resulted in improved communications and a more economical quality assurance operation for both NASA and DOD. Upon completion of the initial training, DCAS arranged to maintain a training capability to meet future requirements resulting from personnel turnover and changing workload.

Personnel

As the space program progressed into the late sixties and the beginning of the manned Apollo flights, the significance and value of the NASA–DOD cooperative effort in quality assurance became more evident. The Saturn-Apollo's 15 million parts must each perform its proper function if a mission is to successfully meet its objectives. Clearly, the outstanding success of Apollo,

as well as Gemini, Surveyor, Lunar Orbiter, and others is due to more than mere technical competence. Certainly, a sense of dedication and purpose on the part of each individual associated with these programs has significantly contributed to the success of the most technologically advanced systems yet devised by man. Regardless of the validity and soundness of the concepts, policies, procedures, techniques, and methodology, the effectiveness of a cooperative effort such as this is largely dependent on the people involved—people who have an open, creative, and responsive attitude, people who search for ways and means to accomplish tasks rather than rationalize excuses for not doing them, people who recognize the capabilities and experience of others and learn from them, people who understand the realities of organizational, administrative, and personnel constraints and knowhow to get the job done, people who are unselfishly motivated to do more than the minimum required—these are the type of people who have made the NASA–DOD cooperative effort in quality assurance a success.

DOD Quality Assurance personnel have had a key role in the success of our space program. In recognition of this, over 60 DOD personnel have been selected as special honorees in NASA's Manned Flight Awareness Program and have been invited to witness the launch of Saturn-Apollo flights as guests of NASA. These and other like them will ensure that our past successes continue into the future when our space systems will be more complex, quality requirements more stringent and cost constraints more demanding.

The concepts and ideas formulated in the early sixties and subsequently refined and strengthened in the midsixties, have proved to be a solid base for the cooperative NASA–DOD effort of assuring the quality of space hardware. In fiscal year 1969, DOD quality assurance support for NASA programs exceeded 1,200 man-years of effort. As we look to the future we see new technological requirements and more sophisticated and longer operational missions which will place even greater demands on the quality assurance profession. The experience of the sixties will indeed serve as substantive building blocks for effective NASA–DOD quality assurance endeavors for the space systems of the next decade.

I fully expect both NASA and DOD to derive continued benefits from this "partnership" in the future, to continue to learn from each other and to collectively enhance the overall effectiveness of the Government quality assurance function. We have not, individually or collectively, found the panacea, if, in fact, such even exists. However, this cooperative effort has resulted in a convergence of our respective approaches during the past decade. This convergence will surely continue in the future to the mutual benefit of both the NASA and the DOD. □

WHAT INFORMATION DOES MANAGEMENT NEED

By HERMAN W. MILES
*Director of Development
Defense Documentation Center*

THE DATA REQUIREMENT —WHO DECIDES— MANAGER OR SYSTEMS DESIGNER?

SOME OBSERVERS¹ have said this is an unsolvable problem and that management information systems' designers will never discover what managers require. Managers on their own will probably never discover what they need either. If the problem is insoluble, it is because it is fantastically complex. It sounds simple enough when posed as a single question, but that one question leads to a multitude of others such as:

- What is management and what is a manager?
- What is information?
- What is a decision?
- What kinds of decisions do managers make and how?
- Do managers perform their daily functions by making decisions, and what else do they do which requires information?
- What impact on information systems do managers have?
- What are the organizational relationships which affect managers' decisions and therefore the information required?
- Does the information received by management affect the organizational relationships, etc.?

Forrester² defines management as the process of converting information into action—a process he also equates with decisionmaking.

"KNOWLEDGE IS POWER, KNOWLEDGE IS
SAFETY, KNOWLEDGE IS HAPPINESS"

Thomas Jefferson.

What Is Information?

Webster defines the word information as "the communication or reception of knowledge or intelligence." The importance of information technology is expressed

¹ Robert Anthony, MIT, Conference on Management Information Systems.

² Jay W. Forrester, Industrial Dynamics.

in this definition since the acquisition of information and its transformation into knowledge should ultimately lead to the assimilation of knowledge into understanding and the fusion of understanding into wisdom. Theoretically, managers are chosen because of their knowledge and good judgment based on experience. Information systems and systems designers can ultimately contribute to the success or failure of tomorrow's managers.

Information Systems Costs

How does one go about measuring and evaluating information? How can one predict the value of a system set up to provide it?

1. Information is something that reduces uncertainty, usually at a cost.
2. Information has value only in the context of a specific situation.
3. The amount a decisionmaker should be willing to pay for information depends on the likelihood that it will change his decision.

Levels of Management

Conceptually three different levels of decisionmaking can be structured.

Strategic Planning.³ *The process of deciding on objectives of the organization, on changes in these objectives and on policies that are to govern the acquisition, use and disposition of resources.*

Management Control. *Deciding what is the best way of accomplishing a prescribed task.*

Operation Control. *Assuring that these tasks are carried out effectively and efficiently. The flow of information at and between each of these levels consists of acquiring, storing, transforming, transmitting, controlling and processing information.*

Impact of Computer Technology

The advent of computer techniques for rapidly accessing and manipulating large quantities of data, provides a powerful new tool for increasing the amount of information being generated. It has caused some managers to realize there is as much danger in too much information as there is in too little. The real need is not just for information, but the right kind of information. Since different types cost different amounts of money, the main problem is to balance the value of potential information against its cost. Otherwise, the natural tendency is to seek as much information as one can get for a given cost—a sure prescription for generating mountains of information of the cheapest, least useful kind.

Reporting today is on a preconceived basis. You have to decide in advance what information you are going to need and how often and have procedures for obtaining and summarizing it built into the original system design. The principal obstacle seems to be the identification of precisely what information is needed by each function and each level of the organization with the proviso that an individual may forget the many things one does not need today with some assurance that he can find them again if they prove important.

In the data distillation process, some vital facts inevitably get lost, because the people who should preserve them don't recognize their importance. If a piece of information doesn't fit into a neat category or proves difficult to place in a report the easiest solution is to drop it.

³ R. N. Anthony, Planning and Control Systems.

Mr. Herman W. Miles is the Director, Directorate of Development, Defense Documentation Center—an activity of the Defense Supply Agency. Mr. Miles' mission at the Center is to develop programs that improve the transfer of scientific and technical information within the Defense Department. Mr. Miles was recently selected by the National Academy of Sciences—National Research Council—to serve on the Maritime Information Committee.



INFORMATION FLOW OF CONVENTIONAL DATA SYSTEMS

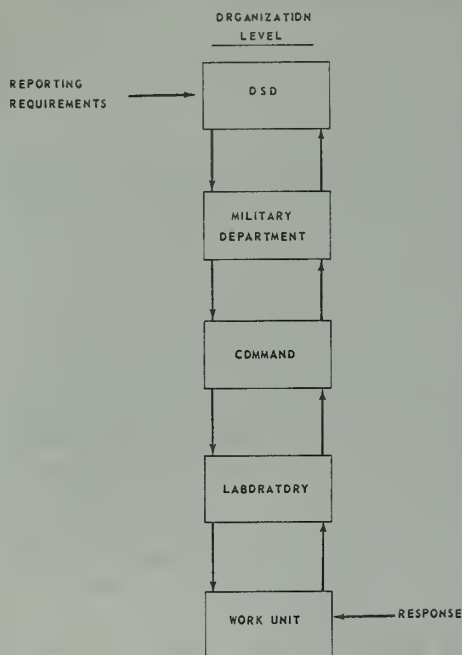


Figure 1

Information Flow of Conventional Data Systems

Information requirements within the military have the benefit of a highly structured reporting channel through organizational hierarchy as illustrated in figure 1. Upon receipt of information requirements outside of the normal required reporting system, there is a need for communicating these requirements downward through the communication chain with all of the vagaries inherent in communicating and interpreting from one level to another. When time is of the essence, a crash environment prevails resulting in individuals at all levels burning the midnight oil to comply with the requirement. The initiator of the requirement is then faced with use of the information without knowledge of how the data has been compiled. In the event he gains some additional insight into his problem and another need occurs, it is generally too late to go through the same process that gets data more relevant to his problem.

Information Flow of Data Base Systems

Advances occurring in the 1960's and better utilization of ADP technology have created the data base concept where, theoretically, data to meet predeter-

INFORMATION FLOW OF DATA BASE SYSTEMS (PREDETERMINED REQUIREMENTS)

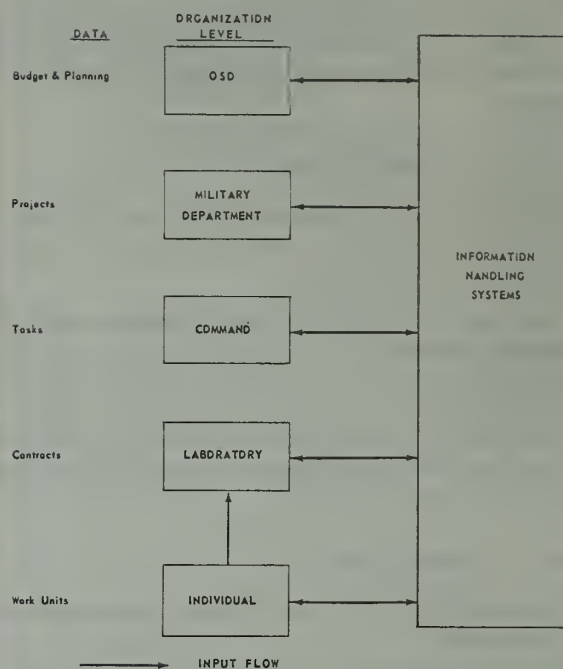


Figure 2

mined requirements of all levels of management can be collected and transmitted directly to the data base. Since an individual is rarely interested in receiving only his information, the data base concept as illustrated in figure 2 would enable a manager at any given level to relate his information with information generated at other levels to put in better perspective, decisions made at his level. Assuming a current data base, the information would be available to anyone at all times obviating the problems typical of the conventional data system employed in the early 1960's.

Predetermined Requirements

The problem with data systems is the identification of those elements to be collected and updated. In addition, how do you determine the arrangement and categorization needs for storage of information in anticipation of future requests? The answer may be systems taxonomy—the study of the general principles of scientific classification or the systematic distinguishing, ordering, and naming of type groups within a subject field. In the fields of science, engineering, accounting, law, medicine, and other activities, professionals have been using and developing classification schemes for years. The success of program planning

and budgeting systems within DOD is the result of an attempt at categorizing the management process. The "Hitch" package employed by DOD for some time is a categorization scheme that has enabled DOD management to acquire insight and visibility of the vast resources requiring the ultimate in strategic planning and management planning. The information presented in figure 2 is another illustration of categorization at different levels starting at the operational control level going through strategic planning. Taxonomies both differentiate and aggregate depending upon whether one proceeds downward or upward in the hierarchy. With the mass of information now capable of being produced by computer systems, our ability to apply different categorization schemes, or even conceive a structure for the systematic and orderly development of categorization schemes, will determine the effectiveness of information that can be successfully employed.

Sackman takes a somewhat pessimistic view of the general problem of systems classification:

—it is extremely difficult, if not impossible, to give an operational definition of classification categories that can be subdivided into independent, mutually exclusive, and exhaustive subcategories * * * the greatest obstacle in the path of successful classification is the refusal to face up to the complexity of the task. Armchair deduction is not enough. Exploratory empirical induction is one of the first steps, based on a continuing census of computer-based systems, periodically updated to keep up with significant changes. The individual systems constituting the bedrock population data base should be empirically described. Numerous system traits should be operationally defined and systematically collected on an exploratory and provisional experimental basis for each computer census. Reliability and validity of trait items should be empirically tested and kept up to date. The more useful traits will persist, others will be dropped, and new ones incorporated into the trait inventory to be tested in turn for their effectiveness. This type of experimental experience will lead to alternative classification schemes. The more successful classifications will evolve and change with the changing population, and as such, could be designated as evolutionary classification.⁴

The Information Management Needs

The day-to-day operational needs of managers at the operational control level are for the most part satisfied through existing reporting systems that quantify data for operating control purposes. The difficulty occurs at the management control and strategic planning level

where it is not possible to rely solely on statistics and formal data. At these levels we must make better use of the vast quantities of descriptive information—the narrative analysis that portrays external factors about the situation in which data reside—text processing. The requirement then is for information systems' designers to recognize and marry the attributes of what loosely has been termed "Management Information Systems" with the attributes of the "Information Retrieval System" to provide that combination of data and narrative pertinent to the situation at hand. Information handling systems of the future must be both content and context oriented.

Current text processing or information storage and retrieval systems require access points in the form of index terms selected from a preestablished word list, i.e., a thesaurus, be assigned for each report by technically competent professional indexers. Current systems also require that requests for information be forwarded to an information processing activity where trained information specialists must restructure these requests in terms of the same word list used in indexing. This use of an artificial predetermined vocabulary that is not necessarily responsive to the changing demands made by the ever-widening horizons of science and technology imposes constraints on both the users of information services and upon information processors. Improvements in information processing technology, particularly in the introduction of on-line communication, necessitate using vocabulary that is natural to the user of the system (who will not necessarily be an information specialist) as access points to the system. The feasibility of using natural language processing requires evaluation in support of a universal taxonomy.

The data base concept requires centralization of the information handling problem. The concept needs to be extended to make the data base a form of a network that rapidly switches a manager to the decentralized activity most knowledgeable, thus combining the best attributes of the information systems flow depicted in figures 1 and 2.

There are some who have advocated the establishment of a cabinet position to handle the Nation's information programs, others have suggested for corporations a vice president in charge of information. The thinking that generated these proposals is equally applicable to all managers. If managers on their own cannot discover what they need, then management information systems' designers must attempt to identify the successful decisionmaker and discern his techniques. By recognizing the taxonomy and the combinatorial processes required for storage and recall of information the systems designer can achieve the ability to *identify and program creative associative patterns* and establish selforganizing, self-adaptive, interactive systems to enhance management decisionmaking at all levels. □

⁴ Harold Sackman, Computers, Systems Science and Evolving Society.

\$AVING WITH \$TANDARD ADP \$YSTEMS *

"We need an understanding of the advantages and opportunities of standard systems, as well as the responsibilities of new participation in systems definition."

IT is a paradox of automated information systems that the more data and decisionmaking we entrust to computers, the more vital becomes the role of personnel supporting these systems. In the automation of management information processing, we are building man-machine systems in which the equipment operators, the computer programmers/analysts and the supply specialists are entrusted with vital roles—key jobs which can mean the difference between a profitable computer application or just another series of computer runs and machine printouts.

Any manager who has watched automation of information systems grow in the last decade recognizes that the human component is a key part of the system. The successful integration of the human element into these man-machine systems is perhaps the most difficult challenge presented to management. Since the human element is the most costly part of the system, we should be giving more attention to this challenge. Selling the system is one of the key steps to establishing a useful relationship between computers and men who are to work with the system—especially those workers outside of the computer room in the line functions.

Selling through education, training, and effective performance will be necessary so long as "resistance to

* Extracts from remarks before the ADP for Top Level Management Course at the Army Logistics Management Center.

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DESC GOES TO MICROMATION

The Defense Electronics Supply Center in Dayton, Ohio, is service testing a new application of a century-old technique in data processing for its parent command, the Defense Supply Agency headquartered at Cameron Station, Alexandria, Va.

The pilot involves micromation—the use of microfilm—which was first employed during the siege of Paris in 1871 and later served in various capacities as the basis for V-mail in World War II and for archival storage in libraries, business, and industry. The technique, improved through modern technology, is being used to advance the flow of data from the electronic computer to the desk of the analyst. Center officials said the concept addresses itself to a problem quite common with today's high speed computers, namely slow-speed output and distribution of information. The traditional medium, impact printing on paper, inhibits speeds and efficiency and often creates bottlenecks, they added.

The new approach, now under study by DESC industrial engineers, replaces paper products with microfilm, thereby increasing the tempo of data dissemination. Presently, the magnetic tape containing output data from a given computer run is placed on a small impact printing computer which types out the listing. Under the new concept, however, the same magnetic tape is placed on a micromation photographic printer which produces a roll of microfilm. The film is developed, reproduced according to the number of copies needed, then placed in cartridges, labeled and distributed. Each 4-inch diameter cartridge contains up to 200 feet of 16 mm. microfilm—the equiva-

change" is a human trait. We have made much progress in getting people to work in close harmony with computers; however, recent trends in getting the most out of our computer resources may make the job of selling the system more challenging. The recent trends I refer to are (1) the establishment of central data systems design and programing organizations, (2) the implementation of standard systems for common functions, and (3) the concentration of computer selection and acquisition resources within each service.

These trends in the development and operation of automatic data processing (ADP) systems may lead the user to believe that the system will no longer be representative of his needs for information. Users may feel that centrally designed and programed systems will not be responsive to changing operational needs. These are instinctive reactions in any organization when a

responsibility is elevated to another office. When we move an office file to a central location to eliminate duplication and conflicts between files, there may be a loss of access to the information and less flexibility in the use of information. However, central and standard systems design and programing have demonstrated that this new trend can improve overall performance and operations—especially at depot and inventory control point (ICP) activities of the Defense logistics system.

The advantages of these standard systems may not be readily apparent to all people who are affected by the systems—especially people who must change from a nonstandard procedure to a new way of doing business that was "not invented here." These computer systems introduce new interdependencies between systems analysts, programmers, telecommunicators, buying officers and supply managers which make the advantages even



Micro-fashioned Karen Cross illustrates space-saving features of DESC's micromation system. Information normally impacted on stack of printouts (in carton on table) can be stored completely on single cartridge of film held by Miss Cross.

lent of 4,000 pages of printout material or a stack of printouts nearly 2 feet high.

The micromation system can translate what constitutes 7,000 lines, or 120 pages, of computer printouts in 1 minute, or an equivalent of 30,000 pages of information during an 8-hour shift. This includes setup and handling time, officials said. Present impact printers operate at 1,000 lines per minute; consequently, the new system is roughly seven times faster.

Officials said although micromation offers numerous advantages, it will not be functionally nor economically feasible to apply the concept to all computer output products. In some departments, particularly where information must be constantly updated, where volume is small, or where copies are spread out for individual operations, paper reports will continue.

A complete micromation printing system has been installed to process the computer output data directly from magnetic tape through photographing, developing, reproducing, splicing, cartridge loading, and finally, viewing by the analyst. To read the microfilm, DESC has positioned 66 viewers in three major departments: the Directorate of Supply Operations, Directorate of Storage and Transportation, and the Directorate of Technical Operations. Eighteen of the viewers are equipped with printers to provide conventional copies of the filmed material if needed.

The chief advantages of micromation, officials reported, include conserving computer time, eliminating bottlenecks in distributing information, reducing storage space and filing equipment and, most certainly, improving service to the employee who is using the information in support of the customer. Overall, the system is considered less expensive than impact printing, officials indicated.

less apparent—and make the job of selling the system more difficult.

Glib salesmanship and public relations campaigns are not appropriate for selling these systems. What is needed is an understanding of the advantages and opportunities of standard systems as well as the participation of users in systems definition and improvement. Let us review the advantages which accrue from these centrally developed, standard systems.

Best Use of Limited Resources

The most obvious advantage of centralizing controls of design and programing is getting the most out of our limited and costly ADP resources. We are all aware of the shortages of skilled ADP systems analysts and programers and of the competition that exists between industry and Government for this talent. During fiscal year 1968, salaries for the 22,000 programers and analysts in the DOD amounted to \$278 million. We must manage these resources carefully and eliminate competing, overlapping, duplicative systems development and programing. Sharing program documentation and software has helped to conserve these scarce resources, but this is not enough. New organizations have been established in each service to facilitate programing at the lowest possible cost by centralizing control of all programers and analysts.

Pressures will increase to optimize personnel cost as it becomes more obvious that personnel is the most costly part of the system. Technology is making computer hardware more effective at less cost. Computer equipment today is only one-tenth as costly per unit of output as it was 10 years ago. There is no such trend in the cost-performance ratio of computer personnel. On the contrary, recent events leading to the separate pricing of hardware and software will serve to emphasize the increasing costs of personnel.

Application of Advanced Techniques

Central design activities are in a better position to support and exploit new information systems techniques and specialized skills. For example, recent years have seen the emergence of the systems programers and analysts as distinct from applications programers and analysts. These systems programers are generally more familiar with software: executive systems, assembly level language and even machine level language. They are programers' programers—specialists among programers—who can keep abreast of advanced techniques in data management systems and modular programing which can increase the flexibility and efficiency of all systems they support.

Best Solution to Common Problems

The development of a uniform ADP application avoids the proliferation of different automated tech-

niques to implement a single policy directive. While these proliferations basically represent the wasteful use of personnel, most significant is the loss of control through variations in timeliness and effectiveness (or ineffectiveness) of different implementations.

For example, on the first of July 1969, DOD requisitioning procedures were extended to include back-order reconciliation of military assistance requisitions outstanding. In one Service, which now permits each ICP to do its own programing and systems design, two of the eight ICPs implemented the extension out of time phase and implemented with erroneous criteria, so that supply support on several items was erroneously canceled.

Avoiding proliferation is a negative identification for the most significant positive advantage of standard system development. Stated more positively, standard systems involve the joint searching for the best available solution to common problems. In the logistics system, here is a sample of the common functions for which we need better solutions:

1. Application of weight and cube data;
2. Maintenance and use of shelf-life data;
3. Shipment planning;
4. Purchase operations;
5. Equipment maintenance records;
6. Analysis of demand data.

These are all candidates for standard systems development.

Satisfaction of Information Requirements

Along these same lines, central controls over systems design make it possible to consider a broader range of requirements at several management/operating levels throughout DOD. Thus, central systems development should provide a perspective of information requirements which is not available to any one of the total logistics systems: i.e., relating materiel requirements to financial and maintenance planning. Management controls developed with this perspective are more apt to provide data and control needed at the right time and organizational level. The basic problem in many automated information systems is that the systems definition did not identify all requirements for information. The discipline and perspective of central data systems design activities should work to correct this problem of validating requirements for data.

Many reports used at military service headquarters, joint commands and the secretarial levels are not what they should be—they are not byproducts of routine operations. New arrangements for systems control should enable us to develop information systems which will be more responsive to top management information requirements, while at the same time facilitating operations. Too often we have had to extract management

information by superimposing new requirements for reporting.

Better Transferability of Skills

Standard systems provide a basis for transferring skills from one assignment to other assignments. In this way we can protect the investment in training people to prepare input, operate equipment, use output and even to audit the system. Variations in supply systems between Army posts and stations have required significant retraining programs as people move from one station to another. A move from one command to another command can require a reschooling in basic supply recordkeeping for an experienced supply sergeant.

The adoption of standard systems such as the Military Standard Requisitioning and Issue Procedures (MILSTRIP) and Military Standard Transaction Reporting and Accounting Procedures (MILSTRAP) has already paid off in increasing skills transferability between supply activities. But these are limited to interchange of requisitioning, issue, and accounting transactions. As more standard systems are adopted for the full range of depot and ICP activities, people will know the system better and more quickly. This should make it easier to sell the system. Customers can use the same language—terminology, data codes, formats—in talking to all suppliers. Personnel newly arrived from other bases are quicker to pick up operating procedures.

When standard equipment is also adopted as part of the standard procedures, we can assure better and lower cost training for equipment operators. Console operators at Air Force bases are centrally trained and interchangeable among bases without retraining.

Even auditors find it easier to get an insight into standard systems. They don't have to spend as much time learning the system before they can obtain the data they require. Experience with a standard system at other sites can be used to make the auditor's time more productive at all sites using a standard system.

Better Allocation of Resources

Standard information systems allow reasonably comparable evaluations for the purpose of allocating and managing resources. With standard terms, definitions, and procedures, all managers are in a better position to evaluate performance. Until Military Supply and Transportation Evaluation Procedures (MILSTEP) promulgated DOD-wide definitions of backorders and stock availability, each Service and DSA had different measures or definitions of performance. Each component and OSD is in a better position to judge the effectiveness and efficiency of different ways of doing business and alternative approaches to materiel man-

agement and supply distribution with the comparable statistics provided by DOD-wide standard systems.

At the budget table, more comparable performance data should permit more equitable allocation of resources within a supply system and among DOD components. Standard systems enable us to answer such questions as, "Will additional funds provide a greater return in increased performance if they are used to improve depot systems or will we get a greater return if we invest in ICP systems?"

Another advantage is comparable data for manning standards. Within the Air Force, standard systems at Air Force base supply activities have permitted the application of accurate and more valid manning standards to many bases. As a result of these manning standards, personnel authorizations have been reduced at many Air Force bases after manpower validation teams apply comparable standards and workload analysis.

Conclusion

Each service and DSA has independently examined the advantages of using standard ADP systems and has concluded affirmatively that we can:

1. Make better use of limited ADP resources;
2. Improve the utilization of specialized skills and techniques;
3. Find better solutions for implementing approved policies;
4. Provide a framework for integrating many different requirements for information over a longer period of time;
5. Increase the likelihood that skills can be transferred from job to job;
6. Assure more equitable evaluations and allocations of resources—based on comparable information.

In addition to these benefits, one significant gain from standard systems is the leverage given to managers making improvements and reducing costs. The benefits of simple changes to the base supply system; i.e., substitution of magnetic tape records for punched card reports and consolidation of document register printouts, are multiplied by the 146 locations at which the improvements are installed and is expected to produce net savings estimated at \$2 to \$3 million during the fiscal year 69-71 time frame.

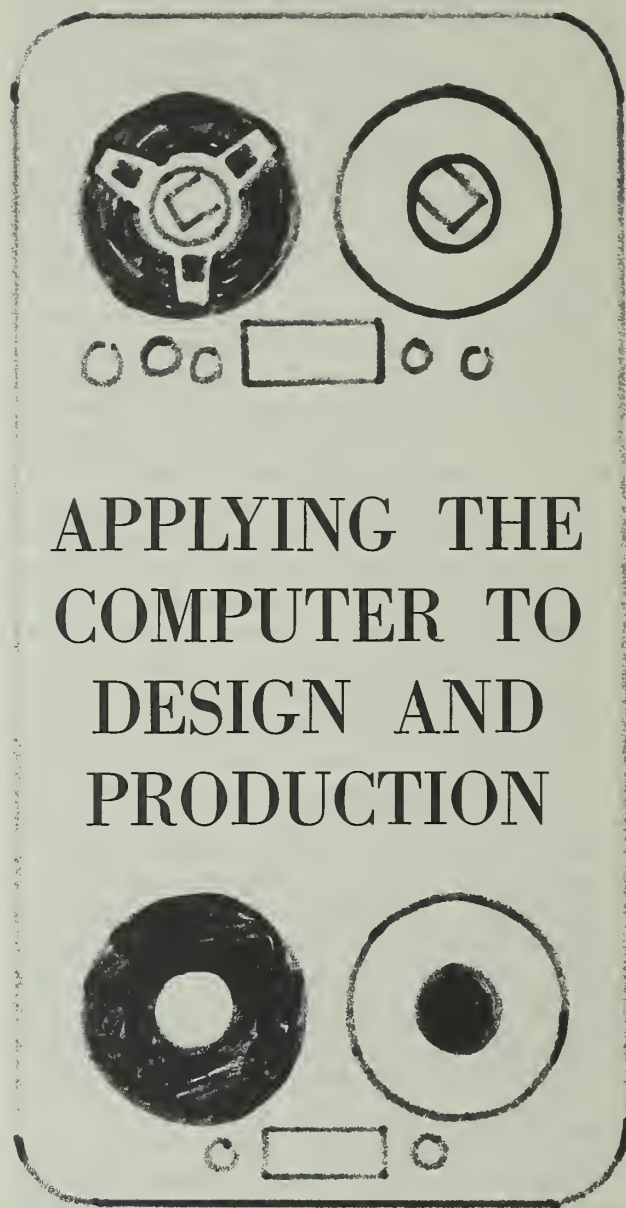
This principle of leverage is two-sided, in as much as the bane of ineffective systems is multiplied manyfold at all locations operating the system. This aspect of leverage emphasizes our initial thoughts on the increasing and vital responsibility of people supporting computer systems. While standard systems provide us with advantages and new opportunities, they also call for the highest quality of personnel available to meet the challenge of systems design. □

ALL OF us are aware, these days, that computers are doing something to our way of life. Those who think of it very much at all usually view the computer as something with which scientists work out long formulas, and the business world uses to print checks which we are not supposed to spindle, mutilate, or fold. But computers are used in scores of other applications with considerable success. They have come of age. We don't read so much anymore where an abacus expert beat a computer in some complex mathematical calculation. In a few nanoseconds or milliseconds a modern computer can calculate tables that would take a roomful of mathematicians a hundred years, including those smarties with their abaci (if that's the plural of abacus).

All this is insignificant, however, compared to what the computer promises when fully applied to design, production, and support of products of all kinds including military hardware. This is not to say that some remarkable things are not being done now by some organizations; but we may be looking back in another decade or so and seeing the 1960's as a technological stone age. This is because man is today barely scratching the potential of the computer and his interface with the computer, considering the design and engineering functions that the computer *can* do much better than man.

Synergism—the concept that the whole is greater than the sum of its parts when the parts can be made to properly interact—is perhaps the proper word to describe the phenomena. When man and the computer can work as partners, with each doing the job it does best $2+2$ can equal 5.

The human mind works best in judgment situations, by trial and error—the interactive process called “heuristics.” The computer, on the other hand, solves prob-



APPLYING THE COMPUTER TO DESIGN AND PRODUCTION

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"Few large companies are not using or actively considering the use of computer graphics today . . ."

lems by the use of algorithms giving exact and rapid responses tirelessly and without error. Prof. Steve Coons of MIT probably said it best, "Man is quite good at inventing and organizing ideas, making associations among apparently unrelated notions, recognizing patterns and stripping away irrelevant detail, he is creative, unpredictable, sometimes capricious, sensitive to human values. The computer is almost exactly what man is not. It is capable of paying undivided attention to unlimited detail, it is immune to distraction, precise and reliable; it can carry out the most intricate and lengthy calculation with ease, without a flaw and in much less than a millionth of the time that would be required by its human counterpart. It is emotionless, or so we suppose. It suffers from neither boredom nor fatigue. It needs to be told only once; thereafter it remembers perfectly until it is told to forget, whereupon it forgets instantly and absolutely" (1).

The great leap forward, or man-machine interface, came about very recently as these things go, with Sutherland's "Sketchpad" project in 1962 which he developed as his doctorate thesis at MIT. He demonstrated that the Cathode Ray Tube (CRT) could be used effectively as a computer input device, which permitted man and computer to talk to each other in a way they had never been able to do before.

The speed with which the CRT has caught on with industry as a computer-graphics, man-machine device—bridging the gap between academic and industrial worlds—has been almost without precedent. Few large companies are not using or actively considering the use of computer graphics today in spite of the relatively high initial cost of hardware, software, personnel, and training.

This condition may not always hold true; one expert said "Computer technology has a way of con-

founding those who would predict its future" (2). But, as the technology develops, prices come down, time sharing techniques are refined, people become better educated in computer graphics, and competition forces new ways to reduce costs, medium and even small companies will get into the act and we shall enter a whole new industrial era. Sure, there are many problems and complexities to overcome, but it is not possible to be exposed to computer graphics and not become excited about its potential.

A glimpse of the world of the future was given by R. A. Sider (et al.) in *Computer Graphics, a Revolution in Design* when a mythical "Charles" sat before the CRT, which looks like a home TV set, and with his magic wand (light pen) called from the computer memory three of the thousands of drawings stored there, which interfaced with the part he was to design. By pointing to line end points with his light pen, pushing buttons to draw repetitive holes, symbols, gear teeth, etc., he was able to draft on the face of the CRT, in theoretically perfect straight lines and exactly positioned features, a "drawing" in one-twelfth the time a draftsman would take. He was able to call for test programs to simulate loads and with the information thus gained, to watch the part deflect on the CRT and thus modify the part so as to optimize section sizes. Charles found that another designer on another CRT who was connected in real time to the same time shared computer, had run a cable through the place where a bracket would go in his (Charles') part, so he was able to cut a notch in his bracket to make room for the cable—this wouldn't normally be found until trouble occurred at assembly. Finally, he was able to make a prototype part by feeding the digital signals he had created and stored in the computer directly to a numerically controlled machine tool.

This had many of the aspects of a fairytale in 1966 when Siders published his book. Today it's not a fairytale at all. Although we don't know that all these things have taken place at one time, the events described are individually practical and have all been employed in actual cases. Furthermore, computer graphics techniques can be used for many purposes which "Charles" had no specific need for his application.

Several years later and not much unlike the fictitious Charles, Coons and Herzog found that "With a light pen and CRT device, the designer can delineate a few important curves describing a shape he has in mind. The surface defined by the curves is exhibited on the display console where the designer can observe immediately the results of his actions. If the characteristics of the resulting curve are not satisfactory, he can modify the original curves; or he can add other curves in regions previously implicit, thereby making his wishes explicit to the computer. When curves are added or modified, the computer alters the previous surface so that the new surface passes smoothly through the new curves until the desired shape is achieved. The mathematical description of this shape is retained by the computer and can be used to produce full-sized drawings, to direct fabricating machinery (e.g., numerically controlled milling machines), to sink forming dies, to produce foundry patterns or to carve out full-sized models" (3).

Thus there seems to be no end to the new approaches made possible by finding new applications for the computer. One company indicated that direct computer driven machine tools, i.e., without an intermediate step of cutting punched tape, can yield a 30- to 40-percent cost saving. The savings are due mainly to reduced machine downtime, simplified maintenance, and less hardware and software for contouring control (4). Aircraft manufacturers sometimes provide tapes rather than drawings to their subcontractors. According to one company representative, it would be possible to control numerically controlled machines in vendors' plants directly from a central computer (4). One aerospace firm claims that 75 percent labor savings are achieved using computer graphics devices to program numerically controlled tools compared to conventional numerical control parts programming (5).

Thurber Moffett of TRW reports that instead of the designs being documented on several hundred or even thousands of paper drawings, it may well be a three dimensional analytic geometry model representing the entire end item, such as a missile, airplane, or submarine. He goes on to state that the model would be as completely defined as the object it represents and be entirely contained in the computer. All designers and engineers would be able to work on the same model by supplying several cathode ray stations to the computer, all operable simultaneously. Hard copy would

be obtainable as desired by either microfilm recording or precision plotter (6).

There is no disagreement with the potential advantages of computer aided design, it remains only to put theory to greater practice. Whenever the design function can be put into mathematical form the computer can be a great assist. The analytic approach to the solution of a problem has several advantages over the slower empirical approach. Varying a system or design parameter in a computer is a simple job which can be done without affecting other parameters. Add to this the great advantages of computer speed, many more parameter variations can be evaluated than would be practical using the conventional method (7).

What does all this mean to the Department of Defense? Curtis McLaughlin of the Rand Corp. suggested in a report to the Air Force that the role of the Government could take one or more of the following forms "(1) to adopt a laissez-faire attitude, with monitoring of business and university activities; (2) to serve as a generator, collector, and disseminator of information on engineering support systems; (3) to support and encourage the setting of standards; (4) to provide direct support for education and for R. & D. in equipment and program systems; and (5) to initiate and publicize computer demonstration projects." Each of these forms is being evaluated by the DOD.

At a recent American Ordnance Association Technical Meeting, it was noted that DOD uses the drawings prepared by the developer as a basis for future procurements. This would include documentation in the form of tapes if this was the means of furnishing the data. Since DOD has control over the procurement procedure, including the final selection of a source, the questions of rights in data is showing its head. But, this must not act as an obstacle (8). The overriding consideration should be the recognition that DOD has the final responsibility for carrying out the intent of the law. Therefore, the data product resulting from computer aided design must be presented in such a form that the data can be interpreted by others and effective competition can be stimulated between several organizations. At the same AOA meeting it was reported that the data is usually produced in a format most convenient to the producer. This data must be converted so that the producer and DOD can see it in a form tailored to their requirements (9). This view is also held by the practitioner in industry as stated by C. S. Perry of McDonnell when he stated that because of contractual requirements calling for drawings to be furnished to DOD there will be a tie-in between the computer and automatic drafting/copying machines (10).

In his listing of considerations that go toward making a valid application of Computer Aided Design Dr. C. B. Newport, Manager of Management Information

Systems at Honeywell's Computer Control Division lists:

"* * * 5. CRT drawings should be acceptable to the user.

6. The drawing should be basically two-dimensional with possible simple excursions into the third dimension.

7. The drawing system should be viable without requiring a large computer and extensive software to undertake elaborate backup calculations.

8. The drawings should be capable of being built up quickly from a small number of predefined objects."

Under the required hardware he includes as part of a maximum configuration.

"* * * 6. Some devices for producing hard copy drawings and schedules. In the simplest system, this may consist of a camera photographing the CRT and a typewriter for printout. For more elaborate systems, a digital plotting table would be needed * * *"

Under software: he stated "It is important that the basic software be established with a firm general purpose foundation and that it can be added to rather than modified, to meet the requirements of a particular application. It's necessary to establish a flexible data structure in which the explicit and implicit content of a particular drawing is held in a form that can be easily processed by the computer" (11).

It is very probable that the drawings and associated documentation produced with the aid of the computer will not have the same physical appearance as they have today. The fact remains that it is possible to produce hard copy documentation when computer aided design is used. Tram Pritchard of Lockheed brought this point out aptly when he stated, "The need for variations in drawing forms will be unnecessary since this technology will be capable of providing technical information in any amount of detail and should be subjected to less detailed restrictions because of its (the computer's) ability to respond to variable demands" (12).

The question of drawings and their transmission to DOD points to a need for output format standardization, and standardized output language. There is also a need to bring about compatibility and interchangeability at several different levels, such as compatibility between different types of drafting machines, between different types of displays, and between drafting machines and displays (13).

It is not easy to draw succinct conclusions from the work accomplished to date. The Computer Aided Design and Production Technology is already available to a large degree. In many cases it has already been

put to good use. The question of how widespread the use will become and how fast, has not been answered to date. More work is needed for an objective analysis of the payoff as related to time and cost. Questions of documentation and standardization have already been posed and some solutions have been suggested.

The most effective DOD role in this technology has not yet been fully determined, but the potential is known and the DOD is moving to exploit Computer Aided Design and Production techniques. This does not necessarily mean support in the way of direct funding. Presently, most of the knowhow and initiative lies in the industry and academic worlds. Strong competitive influences and obvious cost cutting potential has acted as sufficient incentive to move the technology forward at a very rapid pace. DOD's role initially has been mainly one of watchful waiting and nurturing of Industry's Computer Aided Design and Production efforts. But DOD has begun some in-house application of Computer Aided Design and even more of Numerically Controlled production for maintenance lines and emergency spares production.

When Industry becomes more fully committed, the direction taken because of the momentum generated may be impossible to change.

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Report to the President on

MANAGEMENT IMPROVEMENT

in the Department of Defense

Secretary of Defense
October 17, 1969

INTRODUCTION

My years in Congress studying Defense operations taught me that management performance often did not meet management promise. When I became Secretary of Defense I resolved to find out why. This is my initial report to you on what this Department is doing to pinpoint its major shortfalls in logistics performance and how we are planning to cure the deficiencies that caused them. I will be reporting to you on these efforts and on our management plans for the future at the close of each fiscal year.

Our Armed Forces deserve the strongest, most responsive logistics support possible. This Department spends over \$50 billion each year to see that they receive it. That amount serves to replenish, modernize, support, and position a \$162 billion inventory of weapons, equipment, material, and supplies and to maintain a \$40 billion worldwide investment in bases and facilities. These vast resources must be managed prudently—the economic health of our Nation demands it. More important,

“I am sure you will be interested in what the Department of Defense is doing to manage its logistics resources more economically and efficiently. The attached report summarizes this Department’s achievements in fiscal year 1969 and outlines some of our plans for the future.”—Secretary of Defense Melvin R. Laird’s Memorandum for the President, October 17, 1969.

these resources must be managed effectively—men’s lives depend on it.

The best brainpower available is being recruited to map management strategies that will assure these results. Since January, we have:

- Established a Joint Logistics Review Board, consisting of high-ranking military officials, to review worldwide logistics support to combat forces during the Vietnam era, to identify strengths and weaknesses and make appropriate recommendations.
- Convened a Blue Ribbon Panel of nationally recognized management experts from outside the Government to study the organization and management of the Department of Defense as well as its research and development activities in connection with the

procurement of weapons, supplies and other materials, and to suggest reforms.

- Set up a Defense Systems Acquisition Review Council consisting of key Defense Department executives to advise me on proceeding with the procurement of major weapons systems at each critical phase in the acquisition process from contract definition to production for deployment.

At the same time, we have moved quickly to spotlight those logistics programs that need to “get well” or could be “made better.” Cost reduction programs that spur individuals to innovate savings actions are valuable as far as they go. However, economy is only one part—albeit an important part—of good management. The kind of economy that

arises from efficiency is measured, documented, and audited in the Defense Cost Reduction Program. Economies recorded in that program in fiscal year 1969 totaled \$1.5 billion—with 83 percent of this amount reported since January. These savings to the taxpayer exceed the fiscal year 1967 total by 44 percent and the fiscal year 1968 total by 24 percent. Moreover, efficiencies made in fiscal year 1969 will save an additional \$1.7 billion in fiscal years 1970 and 1971. Therefore, the 3-year effect of these fiscal year 1969 cost-reducing actions is \$3.2 billion.

Efficiencies that do not produce measurable dollar savings are often as important as those that do—and sometimes more important. We should be looking for total managerial effectiveness—making the supply system more responsive, tightening up our procurement practices, strengthening our service-type activities (e.g., maintenance, telecommunications, transportation), and streamlining the management of our real property.

Economy and effectiveness are not “either-or” propositions. Both are “musts.”

Consequently, last January I asked Deputy Secretary of Defense David Packard to develop a system that would tell us how well, or how poorly, we were managing our logistics operations. The result is that today we have a new Logistics Performance Measurement and Evaluation System. That system—

- identifies those logistics functions that should be more closely watched than others;
- extracts data from those functions

to permit top management to see at a glance the progress being made;

- sets annual and optimum goals to stimulate progress;
- provides analyses of shortfalls;
- compels management to be prompt and decisive about correcting deficiencies.

Together, the Cost Reduction Program and the Logistics Performance Measurement and Evaluation System are bringing the closest scrutiny to bear on more than 40 important logistics areas. The remainder of this report describes some of the highlights of fiscal year 1969 activity in these areas.

PART I—IMPROVE THE SUPPLY SYSTEM

Logistics begins with planning for new weapons systems, for spare parts and repair materials to sustain these and existing systems, and for all of the consumables needed to keep a 3½-million-man force combat ready. Figuring requirements accurately is a complex job. It is also a critical one. Underestimates weaken our defense posture; overestimates pile up surpluses that ultimately must be disposed of at a fraction of their original cost.

A. By Identifying Owned Assets

To plan wisely, we must first know what we already have—and, to do that, the Defense Department must “take inventory” like any prudent businessman. Defense inventories, however, are infinitely larger, considerably more varied, and far more widely positioned than any in the commercial world.

Simply identifying the items in our stocks, quite apart from computing quantities, is a mammoth, technically complex job. In fact, Defense Cataloging Activities were able to provide complete descriptions for only 27 percent of the 287,491 items they cataloged in fiscal year 1969. On the other hand, a better picture is presented in the production of the precise descriptions needed for procurement. In fiscal year 1969, the Military Departments completed on schedule 93 percent of their 5,000 specification projects to update and, through 1,200 of these projects, supplement the 28,000 active military and Federal specifications available for Defense use at the beginning of the year.

The proliferation of manuals, data, and reports for weapons systems and equipments compounds identification problems. Defense spends about \$2 billion annually for technical data. Current inventories consist of 50 million engineering drawings, a million bills-of-material, half a million pieces of administrative data, and more than 250,000 technical manuals. In recent years, some progress has been made in harnessing this paper deluge. A new specification, MIL-D-1000, has improved the procurement of engineering drawings by specifically relating requirements and formats to intended uses. The Armed Services Procurement Regulation now prescribes a deferred ordering concept to prevent buying data in advance of proved needs. All Services now use a common form for ordering data from contractors. New policies for pricing data have been devel-

oped. However, more can be done by:

- screening data requirements more stringently during the precontract award period;
- using contractor's data formats where possible instead of requiring the contractor to recast the data into military format;
- inspecting data more thoroughly before accepting it; and by
- standardizing and streamlining the storage and retrieval of data.

Data management practices innovated this past fiscal year will save \$29.1 million in the 3-year period fiscal years 1969-71. For example:

- An Army study showed that monthly data submissions on the status of SAFEGUARD SITE ACTIVATION could be changed to quarterly, saving \$24,000 in the 3-year period fiscal years 1969-71.
- The Navy found that the Government Printing Office could provide photolithographic negatives of camera-ready copy for printing technical manuals at less than half the price the equipment contractor had been charging for providing the same item, saving \$183,600 in fiscal year 1969.

B. By Strengthening Inventory Controls

Inventory control and inventory identification go hand in hand. Both are needed to provide a base for accurately determining requirements. Moreover, the dynamics of the supply system make control harder to come by than identification. Inventory levels rise and fall every hour of the day. Supplies are distributed to 12,500 bases around the world as well as to troops in a combat zone over a 10,000 mile pipeline. Our 22 Inventory Control Points and 191 major storage activities handle 80 million receipts and issues annually. In this environment, it is a tough job to pin down on-hand quantities for each of the 3.9 million items in our inventories. Duplicative and unneeded items in the supply

system do not make that job any easier. As a matter of fact, the number of items in inventory would have been more than 8 percent higher in fiscal year 1969 if Defense Technical Review Activities had not prevented 54,437 duplicative items from entering the system and if technical analysis had not identified 276,087 additional Defense items for elimination from the Federal Supply Catalog.

Good inventory practices begin with accurate records. Requirements for most supplies are impossible to calculate accurately if recorded assets do not reasonably reflect the kinds and quantities of materials in storage. Logistics experts consider a 95 percent accuracy rate in depot level inventory records to be reasonable. Yet, as of January 1, 1969, the locator record accuracy rates of Army, Navy, and the Defense Supply Agency fell below that goal. By June 30, 1969, increased emphasis in this management area had raised the accuracy rates of all Military Departments and DSA close to or above the 95 percent target.

C. By Refining Requirements

The most effective way to keep our supply system lean and fit is to use a sharp pencil in computing the requirements that generate inventories. Reevaluations of programed needs are producing tremendous economies. All told, new insights from these "second looks" saved the Department of Defense \$429 million in fiscal year 1969 and will save \$677 million in the 3-year period fiscal years 1969-71. The three subjects of these refined calculations were major items, initial provisioning, and secondary items.

Major Items

The Department of Defense spends about \$18 billion a year for ships, planes, missiles, and other major items. Analyses of tables of allowances, more efficient deployment of weapons, studies of the combat effectiveness of major weapons, and

continuing program reviews help the military services calculate their requirements more precisely. For example:

- The Marine Corps bought only secure-type radio sets instead of both secure and nonsecure types when an analysis showed that the former would meet all tactical needs and would reduce the unit cost 20 percent below the average unit cost of a procurement of both types, saving \$459,928 in fiscal year 1969.
- The Air Force cut 25 units from its programed requirement for test sets to check out airborne countermeasures systems when an analysis of tables of allowances showed that one set per base (instead of one set per squadron) sufficed, saving \$1,785,000 in fiscal year 1969.

Initial Provisioning

Weapons systems must be supported with spares and repair parts from the first day they become operative in order to assure their readiness at all times. As a result, Defense is faced with committing about \$1.4 billion annually to the purchase of support and maintenance items for which no experienced data exists on wearout rates, repair time, distribution time, etc. Despite these handicaps, supply managers found many innovative ways in fiscal year 1969 to reduce and firm up these initially provisioned requirements. For example:

- The Army eliminated a requirement for standby power units for semitrailer mounted electronic shops when study of a similar item showed a zero failure rate, saving \$108,960 in fiscal year 1969.
- The Navy reduced its requirement for repair parts for various devices in digital subscriber terminal equipment when analysis revealed that 1,200 different parts were common to two or more devices, saving \$298,670 in fiscal year 1969 and \$1,039,670 in the 2-year period fiscal years 1969-70.

Secondary Items

The Department of Defense spends about \$6 billion a year to replenish its \$22 billion inventory of spares and repair parts, and spends an additional \$5 billion annually to sustain adequate inventory levels of minor end items (soap, bandages, handtools, etc.), bulk items used in repair (sheet aluminum, welding rods, gasket material, etc.), and other consumables (food, fuel, clothing, etc.). Many opportunities exist for reducing programed quantities of such items by obtaining more precise fixes on wearout rates, loss ratios, pipeline factors, etc. For example:

- An Army medical center eliminated its intermediate stockage point for 237 medical items by instituting a system for direct issue from the medical supply area to the customer, saving \$38,228 in fiscal year 1969.
- The Air Force canceled procurement of 330 inert practice fuzes for training munitions handlers when analysis showed live fuzes in long supply could be converted to inert, saving \$73,738 in fiscal year 1969.

D. By Insuring Responsiveness

A military supply system is effective only if it regularly satisfies the demands of its customers on time. Are items on hand when requested? How many back orders are there? How old are they? Questions like these go to the responsiveness of the system—and we are finding that there is room for improvement. For example, fill rates for stocked items available when requested range from a low of 60 percent in the Marine Corps up to a high of 90.1 percent in the Defense Supply Agency. Also, back orders outstanding at the close of fiscal year 1969 totaled 1,363,147—and 75 percent of these were over 3 months old. We plan to improve these conditions in the year ahead.

Responsiveness is improved whenever we can relieve demand for new

procurement by using up items in our \$15.3 billion worth of long supply and disposable assets. Stocks of this kind returned to productive use in fiscal year 1969 totaled \$1.4 billion. Not all of these reutilizations count as cost reductions—only those where real ingenuity is demonstrated either by modifying the excess item to fit a current requirement or by adapting it to a use other than the one for which it was intended when purchased. For example:

- The Bluegrass Army Depot at Lexington, Ky., converted three excess cargo trucks to refuse haulers (like Dempster Dumpsters), saving \$34,137 in fiscal year 1969.
- The Air Force modified 16 excess dummy missiles for use in drop tests of another type of missile, saving \$563,693 in fiscal year 1969.
- The Defense Supply Agency issued 22 million feet of inside switchboard cable that was excess to satisfy requirements for outside drop-wire cable, saving \$32,852 in fiscal year 1969.

Innovative applications of excess and long supply reduced programed demands for items by \$71.6 million in fiscal year 1969.

PART II—IMPROVE PROCUREMENT PRACTICES

Last year this Department's 18,000 professional procurement people transacted over 10 million purchase actions valued at \$42 billion. Only

2 percent of these purchase actions were valued at \$10,000 or more, but even that relatively small fraction of total purchase activity covered awards to as many as 24,000 different prime contractors. The primary responsibility of these procurement officials is to see that Defense receives top value for its purchase dollars. Our objective is to pay sound prices for the goods and services we buy—and to assure that result we must have more economical buying practices, fuller competition, more and better value analysis, and tighter quality control.

Some examples of procurements shifted from prime contractors to manufacturers are shown in the table below.

A. By More Economical Contracting Techniques

Contract Forms

Letter contracts and undefinitized change orders are contract forms that authorize contractors to start work before pricing is agreed upon. Where prices are absent, contractors have no incentives to hold costs down. The longer these contract terms remain undefined, the greater the likelihood that the contractor will have run up costs that could place the Government at a decided disadvantage in negotiating a price that will force the contractor to apply his best cost-cutting efforts. Although necessary in some situations (particularly when drawn out negotiations would delay production of urgent requirements), these

	Prime price	Manufacturer price	Percent reduction	Fiscal year 1969 savings
Low inductance capacitor . . .	\$555. 64	\$419. 70	24	\$210, 645. 00
Turbine assembly	2, 920. 00	2, 621. 00	10	40, 365. 00
Staging rocket motors	7, 748. 53	4, 960. 94	36	713, 623. 00
Cathode ray tube	8, 245. 00	5, 000. 00	39	38, 840. 00
Parts kits for miniscope . . .	212, 191. 80	158, 013. 18	26	54, 178. 00
Conditioning/interface equipment	15, 132. 00	5, 280. 00	65	119, 964. 00

contractual arrangements are discouraged—and rapid definitization of these contracts is encouraged. We have made some progress—most of it since January—in firming up such contractual commitments.

- The value of letter contracts outstanding decreased from \$4.7 billion as of June 30, 1968, to \$2.2 billion as of June 30, 1969, while the value of those not processed within 6 months decreased by \$826 million during the same period.
- The value of undefinitized change orders decreased from \$2.2 billion as of June 30, 1968, to \$1.9 billion as of June 30, 1969, and the value of those over 6 months old decreased by \$248 million in the same period.

Direct Purchase Breakout

Sounder prices are obtained whenever middleman markups are eliminated. By breaking out parts and components from major systems and subsystems, we are often able to procure these at a lower cost from the manufacturer or vendor. By supplying these parts and components to the prime contractor for the weapons system, we avoid his markup on items that he otherwise would have subcontracted for. These "direct purchase breakouts" saved Defense \$12.9 million in fiscal year 1969.

Multiyear Procurement

Consolidating 2 or more years' requirements in a single contract reduces costs. The bigger the production quantity, the greater the incentive for bidders to pare their cost estimates. Substituting one contract for several eliminates the Government's administrative cost of repeated purchases and cuts out recurring startup costs for the contractor. Enough multiyear requirements were consolidated into single contracts during fiscal year 1969 to save the Department of Defense \$34.8 million. Some examples follow:

	Unit price		Fiscal year 1969 savings
	Single year	Multiyear	
Night vision sight housing for machine gun.....	\$726	\$577	\$302, 619
Gyro magnetic compass set.....	2, 028	1, 800	60, 983
Naval projectile.....	187	172	450, 000
Mechanical time fuze.....	44	23	1, 158, 740
Two-cyro platform system.....	14, 990	9, 550	140, 768
Aerial stores adapter.....	172	165	51, 408
150-ton air conditioners.....	85, 853	73, 604	220, 482

B. By Fuller Competition

Defense buyers know that competition is the best determinant of a sound price and they seek it out and apply it wherever reason and practicality permit.

Spare Parts Breakout

Major systems and subsystems are screened by technical teams to identify those high-dollar value parts and components that appear to have good potential for attracting competitive proposals. Our success in "breaking out" such items for separate procurement is always influenced by the commodity mix. For example, aeronautical spares traditionally pull in less competition than, say, spares for electronics equipment. In fiscal year 1969, 32.9 percent of all replenishment spare parts were obtained through competitive procurement.

Shift from Sole-Source Buying

In fiscal year 1969 Defense buyers obtained competitive prices on items

that had a history of sole-source procurement. The difference between the higher noncompetitive prices previously paid for these items and the fiscal year 1969 competitive prices totaled \$64.2 million. In addition to these savings on fiscal year 1969 procurements, these lower competitive prices will cut \$87.5 million from purchases programed for fiscal years 1970 and 1971.

A few examples of procurements shifted from sole-source to competitive in fiscal year 1969 appear in the table below.

C. By Better Value Analysis

It is just as wasteful to buy unneeded technical characteristics as it is to buy unneeded quantities. To insure that the products we order are scaled to the users' requirements, value engineers are constantly evaluating alternative ways to make an item so that it can perform the desired function at lower cost. In addition, value engineering, prop-

	Noncompetitive unit price	Competitive unit price	Percent reduction	Fiscal year 1969 savings
40-mm. grenade launcher..	\$3, 345	\$2, 050	39	\$646, 705
Aircraft engine support....	710	220	69	11, 168
Traveling wave tube.....	3, 211	1, 791	44	765, 000
Translator synthesizer....	2, 245	1, 740	22	101, 000
Rotary joint for antenna..	1, 675	274	84	116, 000
Semiconductors for				
A/C fire control.....	129	40	69	232, 379
Bronze sleeve bearing.....	147	16	89	42, 245

erly applied, improves quality, reliability, producibility, and performance. Value engineers lower costs by applying advances in technology, considering changes in users' needs, questioning all specifications related to a product, examining design deficiencies, locating and reviewing high cost areas, and analyzing feedback from test use.

This Department documented value engineering savings of \$342.2 million in fiscal year 1969. The table on this page contains typical examples.

In addition to the substantial value engineering being conducted within the Department of Defense, Defense contracts contain incentives for contractors to propose value engineering changes on items being purchased from them. Approved contractor proposals totaled 1,221 in fiscal year 1969—24 percent more than in the previous year and the largest number in any year since fiscal year

1964 when the incentives were first offered.

The Government must render prompt decisions on contractor proposals to continue the momentum of this program. Normally, a significant number of contractor proposals are always in the evaluation stream. Delays in accepting or rejecting these proposals can seriously damage a contractor's motivation to take advantage of the value engineering incentives offered him. Consequently, the processing time for value engineering change proposals is closely watched. Forty-six percent of all value engineering change proposals on hand as of July 1, 1969, were over 60 days old. We believe this rate can be substantially reduced.

D. By Tighter Quality Control

Just as value engineering weeds out unnecessary technical characteristics, quality controls guarantee the presence of the necessary ones. Con-

tractors are charged with verifying that the products they offer Defense meet contractual requirements. Defense quality assurance personnel make sure that contractors discharge that responsibility. In the past year this Department—

- established uniform practices for administering procurement quality assurance programs at manufacturing facilities (Handbook "H-57" dated June 1969);
- improved the Defense-wide utilization of calibration laboratories;
- witnessed the incorporation of many of its policies and procedures into NATO programs.

PART III—IMPROVE SUPPORT AND SERVICES

Logistics systems require a wealth of backup activity. Tremendously complex information networks give these systems cohesiveness. Far flung transportation facilities deliver the goods—and the people—on time. Huge maintenance complexes keep our resources in tip-top shape. These support services—so necessary to responsive operations—create their own management problems.

A. By Providing More Efficient Information Service *Automatic Data Processing (ADP)*

High-speed computers render quick, precise readings on assets and needs so that we can better predict requirements. Fast feedback systems provide data on combat-use rates, prospective performance, and past and current production. Data systems also show failures of producers to meet schedules and pinpoint the delinquent production phases. These uses illustrate the heavy reliance Defense places on automatic data processing systems. In fiscal year 1969, DOD activities spent over \$1 billion to operate some 2,700 computer systems (of which 735 directly serve logistics operations). Over 82,000 persons work at designing, programming, and operating these computers. A recently published Logistics Planning Blueprint outlines concepts for automating our worldwide materiel

	Unit cost		Savings on recent procurement
	Before redesign	After redesign	
1. Flare parachute..... Substituted aluminum thimble for brass.	\$3. 342	\$3. 077	\$250, 700
2. Skin assembly for aircraft stabilator.... Substituted stainless steel for titanium.	600. 00	95. 00	214, 625
3. Electric throttle control for generator.... Eliminated by modifying lever on engine carburetor to perform same function.	478. 00	21. 91	48, 200
4. Calibration test for high-speed camera mounts..... Simulated full-scale rocket sled runs by using miniature model sled.	6, 423. 00	3. 10	317, 188
5. Synthetic penicillin..... Reduced potency requirement from 3 to 2 years when study showed stocks were regularly used up within 24 months.	46. 50	40. 58	132, 276
6. Bandage scissors for field medical kits.... Redesigned, reducing weight 90 percent, replacing metal handle with plastic, and eliminating unessential catch and spring.	8. 79	1. 89	270, 122

systems over the next 5 years. In the past year, Defense managers have effected economies in the management of our computer resources by increasing machine room productivity, improving programmer utilization, making fuller use of existing facilities through sharing, and acquiring computer capacity at less cost by lease/purchase analyses. Savings generated through such actions in fiscal year 1969 saved \$14.4 million that year and will save \$50.9 million in the 3-year period fiscal years 1969-71.

Telecommunications

Cost-comparison studies help us make economic choices in managing the Defense Communications Systems. These studies help us determine in particular situations the advisability of converting to Wide Area Telephone Service (WATS) as common user circuits, the need for transportable facilities, the desirability of relocating existing facilities, the feasibility of consolidating traffic distribution points, telephone exchanges, terminal devices, etc. For example, the Air Force canceled its lease of commercial lines between bases in Florida and Puerto Rico when a study showed that spare circuits in Government-owned cables could be substituted, saving \$282,100 in fiscal years 1969-71. Improvements like these in the operation of our telecommunications in fiscal year 1969 saved \$31.4 million in fiscal year 1969 and will save \$68.2 million in the 3-year period fiscal years 1969-71.

B. By More Effective Transportation

During fiscal year 1969, the Department of Defense moved 32.2 million short tons of dry cargo and 6.5 million passengers within the continental United States and 15.7 million short tons of dry cargo, 26.4 million short tons of POL and 3.5 million passengers overseas. These services, provided by commercial as well as DOD-owned land, sea, and air resources, cost approximately

\$3.7 billion, excluding any investment in equipment. In fiscal year 1969, Defense transportation managers introduced over 1,400 improvement actions that saved \$80.6 million in fiscal year 1969 and will save \$134.1 million in the 3-year period fiscal years 1969-71. These actions included: Increasing the use of containers and container ships; expanding terminal capabilities (tracks, docks, and locomotive power) to make greater use of rail services; authorizing additional overtime work by longshoremen to speed up shiploading and discharging; negotiating lower rates, fares, and charges for moving cargo, personnel, and mail by air carriers; rescheduling ship departures so vendors can transport goods directly to port; restructuring airlift route patterns; and scheduling Special Assignment Airlift Mission aircraft to move cargo directly from origin to final destination.

C. By More Efficient Maintenance

Equipment maintenance is this Department's largest servicing activity. Ninety-four military depots

(employing 227,000 people) and several hundred contractors overhaul and repair our \$100 billion of equipment in use at a cost of \$6 billion a year.

Because our aircraft inventory alone is valued at \$43 billion, it will receive considerable attention in the months ahead. We will closely follow indices on—

- maintenance hours per flying hour for selected series of aircraft;
- modification management, i.e., timely incorporation of changes in selected series of aircraft;
- mean time between engine overhaul for certain types of engines in our \$9.9 billion aircraft engine inventory. (Our objectives are to identify the improvements that result in increased engine life and to cut out unneeded overhaul.)

Measurable economies resulting from innovative equipment maintenance actions during fiscal year 1969 saved \$95.5 million last year and will save \$254 million in the 3-year period fiscal years 1969-71. The following examples illustrate the kinds of improvement activity generated in fiscal year 1969.

	Savings	
	Fiscal year 1969	Fiscal years 1969-71
Helicopter fuselage repair..... The Army designed repair equipment permitting rebuilding locally instead of shipping to a distant depot.	\$15, 500	\$25, 900
Aircraft fuel and hydraulic Systems..... The Navy revised its policy from "total overhaul" to "inspect components and repair as necessary."	947, 263	2, 924, 797
Seal for compressor spacer assembly..... The Navy stopped replacing seals worn to 0.072-inch tolerance when tests proved wear limit to 0.082-inch tolerance did not affect safety or performance.	120, 192	240, 384
Aircraft engine cylinders..... The Air Force developed a new welding procedure for repairing worn assemblies instead of replacing them.	88, 915	177, 830
Brake lining check..... The Air Force designed a testing gage that reduced by 94 percent the time spent on brake lining checks.	29, 100	87, 690

PART IV—IMPROVE REAL PROPERTY MANAGEMENT

The Department of Defense is the world's biggest landlord with forces occupying about 1,000 major and 11,500 minor military installations throughout the world. Our 31 million acres of land is valued (with improvements) at \$40 billion (including 375,000 family housing units valued at \$5 billion). As a result of continuing reviews that square these assets against changing defense requirements, this Department selected a number of activities in fiscal year 1969 for closure, reduction, realignment, or consolidation. These actions, after considering offset costs, will save almost \$109 million by the end of fiscal year 1971 and will save substantially greater sums in subsequent years as the phaseouts near completion.

Keeping our real property investment in good condition is a real problem. The current backlog of essential maintenance and repair exceeds \$650 million, considerably more than funds annually available for that purpose. We hope to whittle down this backlog by more scientifically determining the condition of our real property so as to improve the planning, programing, budgeting, funding, and analysis of maintenance organization, workload, and costs. Our long-range goal is to reduce this backlog to a manageable level of about \$200 million.

More efficient management of real property operations during fiscal year 1969 saved \$23.4 million that year and will save \$51.1 million in the 3-year period fiscal years 1969-71. Two typical savings actions follow.

- The programed purchase of an aircraft arresting system and runway extension was canceled when a study showed that grooving the existing runway would provide sufficient braking traction—Savings in fiscal year 1969: \$537,500.
- A study of performance of 500 kw. and 1,000 kw. generators in U.S.-operated powerplants in

Thailand showed that time between overhauls could be safely increased 50 percent for the former and 100 percent for the latter—Savings in fiscal year 1969: \$153,900.

Custodial services (janitorial and housekeeping) are provided for 337 million square feet of our real property at an annual cost of over \$100 million. Though the productivity of the work force maintaining, repairing, and operating Defense real property increased over 12 percent in the last 8 years, servicing costs have increased approximately \$20 per 1,000 square feet over the past 2 fiscal years. We feel that the rise in servicing costs can be slowed by improved supervision, increased personnel training, more stringent review of requirements, refinement of work procedures, improved equipment and materials, improved contract specifications, and by instituting a program for increased work productivity. Surveillance is being maintained over both the in-house and contract cost of service per square foot.

PART V—IMPROVE ALL LOGISTICS AREAS

The Cost Reduction and Management Improvement Programs reach every facet of this Department's operations. No function is immune. In addition to the specific areas described above, these programs are being applied to such areas as:

- The Military Assistance Program, where savings totaled \$5.9 million in fiscal year 1969.
- Administrative Use Motor Vehicles, where costs per mile for maintenance and operation are being closely scrutinized.
- Preservation, Packaging, and Packing, where better processes and lower cost substitute materials saved \$17.2 million in fiscal year 1969.

Efficiencies that do not readily fall into any of the areas previously mentioned are categorized as "General Management Improvements."

These miscellaneous cost reduction actions saved \$248 million in fiscal year 1969 and will save \$746.3 million in the 3-year period fiscal years 1969-71. Some examples follow.

- The Army substituted unserviceable tires for the serviceable tires on vehicles slated for disposal, saving \$19,100 in fiscal year 1969 and \$71,300 in the 3-year period fiscal years 1969-71.
- The Navy eliminated double handling of aviation fuel shipped to Alaska by coordinating orders and schedules so as to permit tankers to take on the fuel from the refinery instead of the intermediate storage facility, saving \$74,000 in fiscal year 1969.
- The Air Force consolidated six accounting and finance offices into four, saving \$243,100 in fiscal year 1969 and \$801,500 in the 3-year period fiscal years 1969-71.
- The Defense Supply Agency cut the costs of short-term cold storage for perishable subsistence items by substituting low cost demurrage on refrigerated railcars for expensive rental of refrigerated warehouses, saving \$161,134 in fiscal year 1969 and \$706,602 in the 3-year period fiscal years 1969-71.

CONCLUSION

When I report to you next year on the status of our logistics management, I expect the record to show a sustained high level of dollar savings in the Cost Reduction Program as well as a marked increase in the effectiveness of those activities monitored by the Logistics Performance Measurement and Evaluation System. I am convinced that by applying strong pressures in the right places through the disciplines of specific goals, audited measurements, penetrating analyses, and hardheaded decisions, we can raise the quality of our management at every level. We are looking for performance that gives the taxpayer top value for his dollar while guaranteeing our combat troops the best support possible. □

**THE VICE PRESIDENT'S REMARKS of October 28,
1969 upon presenting Certificates of Merit for achieve-
ments in the Department of Defense Cost Reduction
and Management Improvement Programs for Fiscal
Year 1969**

Combat is dramatic; systems analysis is not. Ingenuity on the field of battle is readily apparent; initiative within the routine is rarely discernible. Dedicated soldiers are decorated with medals. Dedicated military and civilian personnel, behind the lines, are all too often unsung heroes.

This ceremony pays tribute to some of our unsung heroes and heroines. This ceremony gives recognition to the fact that defense is a team effort. And at no time is a team effort more important than during these years of agonizing over means of concluding an unpopular war without destroying the ability of this Nation to preserve the hard-won peace. Keeping the peace is a thankless business requiring vigilance and perseverance, often without discernible progress.

Peace—not war—is the Defense Department's primary business. National security is a complex enterprise. It is our Nation's most important business. So, it has become our Government's biggest business. And, like all big businesses, it is always in need of improvement.

The cost reduction and management improvement programs have two objectives. The first is to provide maximum logistical support effectively and efficiently. Good management cannot take the credit for military victory, but poor management could be responsible for military defeat.

The second is to provide maximum economy. While economy will never be enforced at the expense of our soldiers in combat or our overall national security posture, it can be positively exercised throughout peacetime operations. The point—to paraphrase Charles C. Pinckney's immortal lines—is millions for defense, but not one cent more than absolutely necessary.

The Defense Department's leaders have recognized the dangers inherent in any massive organization and have taken the initiative in putting their house in order.

It would be easy for the average employee to become a cog in Defense's almost overwhelming establishment. In many ways it is easier for the civilian to surrender to the system than for the soldier to surrender to the enemy.

But it is not within the nature of Americans to surrender docilely. Today, we honor men and women who have never relaxed in a routine nor accepted blandly the status quo. Instead, they have thought critically and creatively about their on-the-job

problems. And ideas—whether in public or private industry—remain America's most important product.

The success of the cost reduction program proves that whether an employee cleans a computer or programs a computer, his ideas count. Defense employees implemented 36,924 cost reduction actions during the 1969 fiscal year. These resulted in validated savings of \$1.5 billion for 1969 and will save \$3.2 billion for the 3 fiscal year period of 1969–71.

This exceeds the 1968 record by 24 percent and the 1967 total by 44 percent. I cannot resist adding that 83 percent of the fiscal 1969 savings were achieved under this Administration.

Today, as we recognize the few, it is important to remember that this record represents the efforts of many. It is the cumulative result of almost 37,000 good ideas. It is the cumulative impact of thousands of individual actions; hundreds, thousands, and hundreds of thousands of dollars separately saved over the course of several years.

In seeing what has been done, we see better what can be done. No idea is too small to be discarded. Every action contributes to the taxpayers' relief. Every military and civilian employee who cares merits commendation for producing this Nation's most priceless commodity—security—at the best possible price.

Economy is a conscious determined, quiet effort. Like integrity, it is proved only never given, but always earned. However, economy, unlike liberty, is not the subject of passionate prose. No public figure has gone down in history for saying: "Give me economy or give me death."

Economy is a conscious, determined, quiet effort. Like integrity, it is proved only when it is practiced, not when it is proclaimed. The Defense Department, from the top down, has made that conscious, determined effort quietly. It has achieved economy with advantage to all and disadvantage to none.

Your success should serve as an example for all the public sector. Along with my congratulations go my wishes that the words of President Calvin Coolidge—spoken in a happier, less sophisticated era—may one day again prove true:

"After order and liberty, economy is one of the highest essentials of a free government . . . economy is always a guarantee of peace."



AWARDS AND HONORS

VICE PRESIDENT Spiro T. Agnew presented certificates of merit at a ceremony on the Pentagon Concourse at 11:30 a.m., October 28, to 10 individuals and to representatives of five organizations that contributed significantly to the Department of Defense Cost Reduction and Management Improvement Programs during fiscal year 1969. The Vice President made the presentations on a stage at the south end of the Concourse. Secretary of Defense Melvin R. Laird was host to the Vice President, with the assistance of Deputy Secretary of Defense David Packard.

The Pentagon ceremony was attended by the Secretaries of the Army, Navy, and Air Force, members of

the Joint Chiefs of Staff, and other high ranking military and civilian officials of the Department of Defense. This ceremony was the highlight of Defense Management Improvement Week observed October 27 through 31 to honor the thousands of Defense employees whose innovations during fiscal year 1969 made Defense operations more efficient and economical.

Secretary Laird reported to Vice President Agnew on October 17, 1969, that more than 36,000 verified management improvement actions resulted in cost reductions of more than \$1.5 billion in fiscal year 1969, and that these same actions would save an additional \$1.7 million in fiscal years 1970 and 1971.



Vice President Spiro T. Agnew presents citations to Mrs. Mary M. Ellington, Defense Supply Agency (left) and Chief Aviation Support Equipment Technician Donald C. Roberts, U.S. Navy, for contributions to the Department of Defense Cost Reduction Program during fiscal year 1969.



At a preceremony briefing in the Office of the Secretary of Defense, Assistant Secretary of Defense Barry Shillito informs the Vice President and other assembled dignitaries that the Defense Department's cost reduction goals for fiscal year 1970 will be 35 percent higher than fiscal year 1969's.



"Economy is a conscious, determined, quiet effort. Like integrity, it is proved only when it is practiced, not when it is proclaimed. The Defense Department, from the top down, has made that conscious, determined effort quietly. It has achieved economy with advantage to all and disadvantage to none."



One Man's Family.—T. Sgt. Anthony J. Diotalevi, an awardee from Clark Air Force Base, Philippine Islands, denied that his high decibel rating on the applause meter as he received his award was attributable to his family (above) seated in the audience.



A Tribute to The Many.—The awardees (seated) hear the Vice President say "83 percent of the fiscal 1969 savings were achieved under this Administration" and "as we recognize the few, it is important to remember that this record represents the effort of many."

Individual Recipients of

ASC Donald C. Roberts
U.S. Naval Air Station
Oceana, Va.



Chief Roberts developed a procedure for rebuilding worn-out static inverters (components of starters for fighter aircraft) to like-new condition instead of discarding them, as had been the practice. His repair technique saved the Department of the Navy \$48,154 in fiscal year 1969 and an additional \$96,308 in fiscal years 1970 and 1971.

Mr. Lionel P. Hernholm
U.S. Army Combat
Developments Command
Fort Belvoir, Va.



Mr. Hernholm studied the distribution of battery chargers used with the TOW antitank missile system and discovered that chargers issued at direct support maintenance levels provided all the combat support capability that was needed. As a result, the Army deleted requirements for backup chargers in the individual battalions. The contract for battery chargers was amended accordingly, saving the Department of the Army \$1,775,106 in fiscal year 1970 and an additional \$4,327,790 during fiscal year 1971.

Mr. James N. Joyner
U.S. Navy Publications and
Printing Service
Washington, D.C.



Mr. Joyner was a principal participant in a study which showed that negatives used for offset reproduction of technical manuals could be obtained from the Government Printing Office at less than half the cost the equipment manufacturer was charging. The new procurement procedure resulting from this study saved the Navy \$183,600 in fiscal year 1969 and will save an additional \$400,000 in fiscal years 1970 and 1971.

Lt. Col. James R. Vance, USA
Department of Tactics
U.S. Army Aviation School
Fort Rucker, Ala.



Lt. Colonel Vance developed a new gunnery training technique for helicopter pilots. His technique gives trainees the same number of practice bursts with less ammunition consumption by employing weapons having a slower cyclic rate of fire. This idea reduced training costs \$260 per student, saving the Department of the Army \$592,800 in fiscal year 1969 and an additional \$2,470,000 in fiscal years 1970 and 1971.

Mr. David E. Ciruli
Pueblo Army Depot
Pueblo, Colo.



Mr. Ciruli developed an air-driven, puller tool to replace the old wedged tool and hammer method for removing shock absorbers from armored personnel carriers. This tool enabled the Department of the Army to eliminate the previous damage-causing removal process and to reduce removal time from 2 hours to one-half hour per vehicle. Savings totaled \$3,600 in fiscal year 1969 and additional savings of \$16,400 are expected in fiscal years 1970 and 1971.

COST REDUCTION AWARDS

Major Frazier constructed a miniature rocket sled model from an aluminum cigar case and an ordinary ping-pong ball. Runs of this model could be used to test and calibrate high speed camera equipment just as effectively as full scale rocket sled runs. Twenty minisled tests could be completed daily as compared to one full scale rocket sled test every 15 to 20 days. The minisled tests saved the Department of the Air Force \$317,188 in fiscal year 1969, and will save an additional \$138,167 in fiscal year 1970.



Maj. John F. Frazier, USAF
U.S. Air Force Missile
Development Center
Holloman Air Force Base,
N. Mex.

Mrs. Ellington broke a sole-source procurement situation on three semiconductors used on the F-101B, 102A and TF-102 aircraft by developing the technical data needed for initiating formal advertising procedures. Resulting competitive procurement reduced the average unit price from \$128.96 to \$40.13, thus saving \$232,379 in fiscal year 1969 and an additional \$186,721 in fiscal years 1970 and 1971.



Mrs. Mary M. Ellington
Defense Supply Agency
Defense Electronics Supply
Center
Dayton, Ohio

Mr. Shupe developed a way to repair worn tripod links in the landing gear of B-52 aircraft by machining away the damaged areas, installing build-up bushings and refinishing the built-up areas to original dimensions. His method saved the Department of the Air Force \$390,753 in fiscal year 1969, and will save an additional \$627,687 in fiscal years 1970 and 1971.



Mr. James W. Shupe
Hill Air Force Base
Ogden, Utah

Sergeant Diotalevi suggested removing arming devices in test firings of certain missiles to reduce damage to FIREBEE target drones. As a result, most drones not destroyed by direct-hit impacts can now be recovered and reused. His idea saved the Air Force \$2,301,494 in fiscal year 1969 and will save an additional \$4,602,988 in fiscal years 1970 and 1971.



T. Sgt. Anthony J. Diotalevi
Clark Air Force Base
Philippine Islands

Mr. Niehaus developed a lightweight, noncorrosive container for illuminating grenades. The old container was bulky and had screw-top threads which often became so corroded as to require a special wrench for opening. The new lightweight container provides better protection, opens quickly by use of ring-pull device, and costs 31 cents less per unit. His idea saved the Department of the Navy \$207,132 in fiscal year 1969 and will save an additional \$147,360 in fiscal year 1970.



Mr. Frank A. Niehaus
U.S. Naval Ammunition
Depot
Crane, Ind.

Unit Recipients of

"This Arsenal is commended for outstanding administration and management of its Cost Reduction and Management Improvement Programs during fiscal year 1969. The motivation, initiative, and dedication exhibited by the personnel and staff of Watervliet Arsenal generated management improvements that saved \$24,900,000 for the Department of the Army, far exceeding established goals. The exemplary performance—achieved under the inspiring leadership of Col. William Mulheron, Jr., Commanding—resulted from exceptionally well organized programs and extensive application of cost reduction and management improvement principles throughout the Arsenal."

"This certificate attests the outstanding administration and management accorded the Supply Center's Cost Reduction and Management Improvement Programs during fiscal year 1969. The Center's accomplishments, which far exceeded assigned goals, reflect the dedication of its highly motivated employees and cost-concerned management staff. Management innovations instituted under the vigorous and dynamic leadership of Capt. S. M. Ball, Commanding Officer—recently retired—and carried forward under the perceptive guidance of the Center's new Commanding Officer, Capt. S. R. Simpson, Jr.—saved the Department of the Navy \$564,900 in fiscal year 1969, and will save an additional \$1,062,000 during fiscal years 1970 and 1971."

"The Air Station is commended for the outstanding results it achieved in managing and administering its Cost Reduction and Management Improvement Programs during fiscal year 1969. Strong impetus to increase employee cost awareness and aggressive command support enabled this organization to far exceed its assigned goals and improvement objectives. Increased efficiency and improved management innovations effected under the alert and intensive leadership of Brig. Gen. Henry W. Hise, Commanding General, saved the Marine Corps \$2,018,000 in fiscal year 1969 and will produce additional savings of \$4,118,000 in fiscal years 1970 and 1971."

"This Division is cited for its outstanding support of the Cost Reduction and Management Improvement Programs. The Division made impressive managerial gains while performing a vital combat mission and improving the readiness status of strategic forces. The Division's numerous management innovations—accomplished by an inspired organization under the aggressive and imaginative leadership of Lt. Gen. A. C. Gillem, Commanding General—saved the Department of the Air Force \$4,454,200 in fiscal year 1969 and will produce additional savings of \$6,391,000 during fiscal years 1970 and 1971."

"This organization compiled a distinguished record of accomplishment under the Cost Reduction and Management Improvement Programs during fiscal year 1969. While working under intense pressure to assure high quality and expeditious delivery of material urgently needed in Southeast Asia, the Contract Administration Services Region enabled buying offices to save over \$9 million on purchases and efficiently monitored contractors' cost reduction programs that saved the Department of Defense over \$24 million. Constant emphasis on economy and opportunities for management improvement under the dynamic and resourceful leadership of the Region's Commanding General, Brig. Gen. Charles H. Phipps, U.S. Army, led to significant gains in productivity, increased accent on value engineering principles and a large number of improvement actions—saving the Defense Supply Agency \$1,500,000 in fiscal year 1969 and an additional \$3,023,885 in fiscal years 1970 and 1971."

COST REDUCTION AWARDS



Col. William Mulheron, Jr. USA
*Commanding Officer
 Watervliet Arsenal
 Watervliet, N.Y.*



Capt. S. R. Simpson, Jr., USN
*Commanding Officer
 Naval Supply Center, Puget Sound
 Bremerton, Wash.*



Brig. Gen. Harry W. Hise, USMC
*Commanding General
 Marine Corps Air Station, El Toro
 Santa Ana, Calif.*



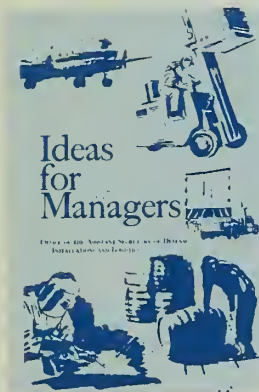
Lt. Gen. A. C. Gillem, II, USAF
*Commanding General
 3d Air Division
 Andersen Air Force Base, Guam*



Brig. Gen. Charles H. Phipps, USA
*Region Commander
 Defense Contract Administration
 Services Region
 New York, N.Y.*



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